SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; J. LE CONTE, Geology; W. M. DAVIS, Physiography; O. C. MARSH, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; N. L. BRITTON, Botany; HENRY F. OSBORN, General Biology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; J. MCKEEN CATTELL, Psychology; DANIEL G. BRINTON, J. W. POWELL, Anthropology.

FRIDAY, OCTOBER 9, 1896.

CONTENTS:

An International Association for the Advancement of Science 505
Address before Section B of the American Association for the Advancement of Science by the Vice-President: C. L. MEES 507
The Cornell Expedition to Greenland: RALPH S. TARR 520
Albert Nelson Prentiss: GEO. F. ATKINSON 523
Current Notes on Physiography:—
Waterways of English Lakeland; Origin of Lake Zurich; Dust and Sand Storms; Physical Geography of New York State; Geography from Nature: W. M. DAVIS 524
Current Notes on Anthropology:—
Origin of the Ancient Indian Alphabets; Explorations in Yucatan: D. G. BRINTON 526
Astronomical Notes: H. J. 526
Notes on Inorganic Chemistry: J. L. H. 527
Scientific Notes and News 528
University and Educational News 532
Discussion and Correspondence:—
A Straight Line as a Minimum Length: THOMAS S. FISKE. *'A Curve-tracing Top' and a Curious Optical Illusion:* C. B. WARRING. *Embryos of the Smooth Dogfish (Galeus canis):* JAMES E. PEABODY. *The Law of Rhythmic Movement:* E. W. SCRIPTURE 533
Scientific Literature:—
Herrick's American Lobster: H. C. BUMPUS. *Isopentane and Hexane. Some Recent Mexican Publications:* JOHN W. HARSHBERGER 536
New Books 540

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison-on-Hudson, N. Y.

AN INTERNATIONAL ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE American Association for the Advancement of Science will meet next year at Detroit, on the Canadian frontier, and will adjourn to Toronto to welcome the British Association to American territory. The British Association has acknowledged this courtesy by inviting the officers of our Association to attend the Toronto meeting as honorary members and by admitting all members and fellows of our Association as members for the meeting. The *Association française pour l'avancement des sciences* has proposed that it should meet at Boulogne in 1898 or 1899, and suggested to the British Association that it should meet at some town on the opposite coast, such as would allow an interchange of visits between the two Associations. This proposal was cordially welcomed, and the British Association will meet at Dover in 1899.

Within the past few years International Congresses for a number of the leading sciences have been organized. In nearly every case each new congress has been more successful and stimulating than the preceding, and the future growth of these congresses is assured. They are accomplishing a work, the importance of which

cannot be over estimated, not only by unifying scientific methods and contributing to the symmetrical progress of science, but also by bringing men of science from all parts of the world into personal contact. A further stage in scientific cooperation has been reached by the decision of the International Zoological and Physiological Congresses to meet together at Cambridge in 1898.

The time has now come when an International Congress for the Advancement of Science is possible. The cooperation between the British, French and American Associations; the successful international congresses in the separate sciences and for scientific bibliography; the establishment of journals, international in circulation, in contributions and even in editorship, are steps in a forward movement leading directly to a world's congress of men of science.

All the arguments that can be urged for national associations for the advancement of science, and for international congresses in the separate sciences, tell in favor of an international scientific congress. Cooperation furnishes both the means and the motive for scientific progress. As science becomes more complex the interrelation of all its parts becomes more evident. It would, indeed, be difficult to mention a scientific question that concerns one of the sciences only. Much good might come from the discussion of purely scientific problems by men approaching them from the most diverse points of view.

There are further many questions which may be regarded as external conditions of the progress of science which can only be settled by international cooperation. These questions usually concern more than one science and often all the sciences. Such are bibliography, nomenclature, the definition of units, libraries and museums, explorations, the teaching of science and many more. Progress results from chance variations and the survival of the fittest, but in a manner wasteful of time and life in comparison with what may be accomplished by intelligent direction.

One of the great advantages of gatherings of men of science is the personal contact and acquaintance which they further. This is an important function of local and national societies and could be attained by an international association to a degree otherwise impossible. Such a meeting would be amply justified if only by bringing together the leaders in the different sciences from the different nations.

Now at the end of the nineteenth century science is the dominant factor in the world. It should be acknowledged as such if only for the more efficient performance of its work. An international congress would impress the collective weight of science on the outside world. If the money and men used in preparations for war could but for a few years be used for the advancement of science preparations for war would no longer be necessary.

The advantages of an international association for the advancement of science seem evident, and the difficulties seem slight. The first year of the twentieth century is opportune for the first meeting. Many men of science will be in Paris, and if London or Berlin should seem more eligible they could easily gather in one of these cities. The preliminary arrange-

ments could readily be made by the American and British Associations in 1797, and the final arrangements by the British and French Associations in 1899.

ADDRESS BEFORE SECTION B OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE BY THE VICE-PRESIDENT.

THE selection of a subject for presentation in an address such as I am called upon to deliver to-day, seems difficult. A large proportion of those who may listen to me to-day are workers in the same field which interests me and are familiar with the progress in the science of physics. It is, therefore, unlikely that I shall be able to present to you anything which may be new or startling; this I regret, for it seems that it requires something of this character to stimulate interest and research.

The aim of science in its most general sense, is the discovery of truths. Its progress may be expressed by a curve approaching truth asymptotically, probably never in human experience approaching to its *complete* knowledge. So long as investigators find that they are working upon the steep part of the curve where it approaches truth rapidly, there is no lack of interest; this, however, seems to die out quickly when much labor and great patience are required to extend experimentally the curve now more slowly approaching complete knowledge, or straighten out some of its irregularities. As soon as a startlingly new or curious line of investigation is suggested every one pounces upon it and older problems are left far from completion. That we in America are especially inclined to this weakness in physical investigations I believe to be the case. Though investigations have been carried out by a number of American physicists, well-nigh to completion, involving years of painstaking labor, of which we may well be proud, yet I believe the tendency exists. It is this thought which has led me to select for a brief review a line of study patiently carried on in Europe for a number of years, yet hardly touched upon by physicists in this country. In the last few years the studies in electrolysis and solution have been so fruitful that we can no longer afford to neglect them. It is also remarkable that these studies in electrolysis and molecular physics have been made almost exclusively by chemists, though of equal, if not greater, interest to the physicists; the problem should be attacked by them. To direct your attention then to some of the important work that should be undertaken by physicists is my object in reviewing, in the briefest possible manner, the progress of studies in electrolysis from their beginning to the present time.

Scarce one hundred years have passed since the first note of chemical action having been produced by electricity is to be found. About the middle of the 18th century Pater Beccari obtained metals from oxides between which electric sparks had passed. These results led to no further inquiry at the time, and were passed by almost unnoticed. Priestley, in 1778, critically studied the effect of the passage of the spark through air, noting the production of an acid gas. Cavendish continued these researches, explaining the action in the sense of the Phlogistic Theory of the day. Van Marum, extending Cavendish's investigations, decomposed ammonia, and through a careful study of the chemical changes brought about by the electric spark became converted from Stahl's Phlogiston Theory, stoutly maintained at the time, to Lavoisier's Oxygen Theory. Van Troest and Dieman, in 1739, gave the first unmistakable evidence of electrolytic action in decomposing water by means of the spark. The tendency towards an Electrical Theory of chemical action, fully developed later,

becomes evident from the study of the literature of the day. These investigations were almost exclusively carried on by chemists; but little attention was given to the study of electricity, its nature and physical action; only the chemical results were of interest. The quantity of electricity at the command of the experimentalists at that time, was so small that very definite results in electrolytic action could not be expected.

So far some progress had been made in the production and study of chemical effects resulting from electrical action; *the question of the possibility of the reversal of these effects, the production of electricity from the chemical action*, had not been thought of. Volta was the first one to investigate *that* question. Galvani's discovery given to the world in 1791 in a brochure of 58 pages gave a new stimulus to investigation, now taken in hand by physicists. The perusal of the little work is of great interest in the historical study of electricity. Galvani, as anatomist, looked for the source of electricity to the phenomena of life, believing it to be stored in the living cell. Volta, the trained physicist, sought for it in the material world and gave us the Contact Theory of electricity as distinguished from the Chemical Theory. These two theories have each been as stoutly maintained as controverted by the best experimentalists and thinkers of the century. Volta's great gift to the world was the Voltaic Battery, the study of which, together with the reversibility of the action, has thrown a flood of light upon problems in molecular physics as well as upon chemical action, though the 'contact theory' of electricity of Volta, accepted with modifications by many of the greatest physicists of this century, has undoubtedly been one of the strongest barriers to the progress of later and more satisfactory theories as to the seat of the electromotive force in the battery.

Passing over many important contributions from co-workers of Volta, laying a foundation for an understanding of the chemical effects of electricity, the most valuable work having perhaps been done by Ritter, we come to Nicholson and Carlisle, who, on the 2d of May, 1800, opened the field for the study of electrolysis by the decomposition of water by means of the current from the Voltaic pile.

Volta seems to have avoided almost purposely the recognition of chemical action associated with the production and action of the current. It is remarkable, at any rate, that such action should have impressed itself most strongly upon all other experimentalists of that day and scarcely be noticed by him.

From this time on we recognize for a considerable period two lines along which electrical problems have been studied. A long list of illustrious physicists from Ermann to Ohm studied the laws and physical effects of current electrical phenomena without questioning the somewhat unsatisfactory theory of Volta as to its source; another list, mostly chemists from Nicholson and Carlisle to Davy and Faraday, sought to determine the source of the current. To trace the development of modern theories historically would demand following both of these lines of research; time forbidding this we will consider but a few of the more important discoveries in each field as required.

Sir Humphrey Davy succeeded in decomposing the fixed alkalies in a fused condition; the separation of the elements from their compounds was by him demonstrated in many experiments.

Before proceeding, however, it may be well to define a few terms used in discussing electrolysis and recall a few of its phenomena.

By electrolysis we mean the chemical changes which result from passing an electric current through a compound, usually in solution or in a state of fusion. The sub-

stance decomposed is called electrolyte. The battery terminals, or source of current, connected by the electrolyte, are called Electrodes—the one bringing the current to the electrolyte the Anode, the one carrying it away the Kathode. As a result of the difference of potential of the electrodes, the materially different constituent parts of the electrolyte are impelled to move towards the electrodes; these wandering particles are called ions; those gathering about or moving towards the anode, anions; those about the kathode, kathions. The chemical changes are observable only at the electrodes. Taking as a simple case, ordinary hydrochloric acid—a compound of hydrogen and chlorine dissolved in water—the passage of the current causes chlorine to appear at the anode and hydrogen at the kathode. The hydrogen and chlorine, while in the solution finding their way to the electrodes, are ions; the chlorine-anion, the hydrogen-kathion. In many cases the action is not so simple. The electrolytic decomposition may be accompanied by chemical action occurring subsequent to or simultaneously with the appearance of the ions at the electrodes; the substance formed differing from the ions actually carried to the electrode. Changes of this character considerably complicate the problem and make the correct interpretation of observed phenomena difficult. This general law may, however, be enunciated: An electrolyte under action of the current is split into two and only two parts, atoms or groups of atoms, no matter how complex its structure may be. These atoms or atomic groups thus separated, are similar to the ones which exchange places in the ordinary chemical reactions. This early observed law led to the theory advocated by Berzelius, that all salts consisted of two atomic groups, one acid the other basic—erroneous, in that the chemical changes subsequent to the electrolytic action were not properly understood.

The wondering attention of early investigators had been directed to the curious phenomenon that the substances resulting from electrolysis appeared only at the electrodes and were not recognizable in the solution between the electrodes. The various theories propounded to explain this vied with one another in improbability. The difficulty of explaining this behavior satisfactorily seems to have led to the abandonment of the problem until, in 1805, Chas. J. D. Freiherr Von Grothuss propounded a theory which gave a sufficiently reasonable explanation to be adhered to for fifty years, even quoted to-day in many text-books. Grothuss conceived that each molecule of a chemical compound acted like a conductor consisting of two parts capable of being separated; these molecules acted upon inductively by the charged electrodes, one group would become positively charged, the other negatively, the nature of the charge being determined by the character of the group, being acted upon by attractions and repulsions, varying inversely as the square of the distance from the electrodes, the electrified *end* particles would be attracted to the electrodes; the remaining groups by separation and recombination would at once form a new series of molecules as before the action, ready for a repetition of the process; no freely charged groups thus remaining in the mass of the solution between the electrodes. This theory demands that the electrical forces between the plates vary inversely as the square of the distance; that, when the force reaches a certain definite magnitude the groups will be separated; a further consequence is that when this critical force is attained all or a very great number of groups will be separated, instantly, for if this attraction be equal to the force holding the groups together, the whole mass will be in unstable equilibrium, and any increase will cause complete separation of all groups.

Important experimental contributions followed one another rapidly, batteries were perfected, many physical actions of the electrical current were studied, the action of the current upon magnets was discovered, measuring instruments for quantitative work were invented, Ohm's law was enunciated, etc., so that when Michael Faraday, Sir Humphrey Davy's man of all work and his successor at the Royal Institute, with matchless experimental genius and wonderful breadth of view, attacked the problem of electro-chemical action, he had at his command the means for quantitative work in this field which enabled him to discover and formulate one of the most important laws of electrolysis. Faraday's charming directness and clearness in the exposition of his work and results contrast refreshingly with the prolix, flowery and mystifying style of his immediate predecessors; it at once stamped him a master of the subject treated. Faraday's original notes are well worth studying; they may be taken as models to-day by many who essay to record experimental results and conclusions. Confusion in terms and errors in inferences occurring in his work are well excusable; from our more extended and accurate knowledge, we are inclined to be unfairly critical. A review of Faraday's work in electrolysis alone would be interesting, for in it we may see foreshadowed many important points in the theories of to-day, though Faraday himself scarcely appreciated them.

The most important law Faraday contributed to the behavior of electrolytes acted upon by a current is stated thus:

The amount of chemical decomposition in electrolysis is proportional to the current and time of its action.

The mass of an ion liberated by a definite quantity of electricity, is directly proportional to its chemical equivalent weight.

The quantity of electricity which is required to decompose a certain amount of a certain electrolyte is equal to the quantity which would be produced by recombining the separated ions in a battery.

The latter law, clearly showing the reversibility of the process, at once makes the problem one capable of theoretical treatment from the standpoint of conservation of energy and has brought most abundant fruit in later years. Faraday, in the main, accepted Grothuss' hypothesis, differing from him in the conception of the character and manner of action of the forces. Faraday showed experimentally, by measuring the change of potential between the electrodes, that Grothuss' conception of attracting and repelling forces, varying inversely as the square of the distance, was untenable; he (Faraday) assumed that through the action of the electrodes the chemical affinities of the combined ions were so changed or weakened that they acquired a greater attraction for the plates and their neighboring opposite ions; that decomposition and recombination occurred along the entire line. With Grothuss, he assumes that each liberated ion has a definite quantity of electricity belonging to it. This theory then demands that the action of the constituent parts of the electrolyte extend to considerable distance, and that the effect of the electrode is to modify or weaken the chemical affinity between the groups so that decomposition results. Faraday leans to the opinion that chemical and electrical forces are identical, and in considering the reversibility of the process becomes an advocate of the chemical theory of the Voltaic cell.

Faraday, though somewhat confused in his nomenclature, brings out very clearly the relations between quantity of electricity and quantity of material separated, and electrical potential and chemical affinity, though at that time the concept of energy and work done, as a function of both potential and quantity of electricity, was not clearly established.

To review the work of Faraday in electrochemistry alone, and the influence it had in the development of the more modern theories, would require more time than is alloted to us; the most important contribution in this subject has alone been mentioned.

In 1851 Williamson, from purely chemical evidence in the manner of the formation of some ethers, was led to believe that in solutions there is a constant interchange of atoms or groups of atoms between molecules, equivalent to dissociation and recombination, a view differing from those previously held, where this condition was supposed to be brought about by the action of the electric current. Williamson made no application of this conception to electrolysis.

Clausius, in 1857, applying the ideas growing out of the Kinetic Theory to solutions, points out the weaknesses of previously advocated theories; he shows that Grothuss' hypothesis, as well as its modifications by Daniell and Faraday, are not in accord with experimental results from accurate measurements. He shows that the hypothesis that the decomposition or tearing apart of the groups of atoms in the molecule by the electric forces, before transfer of electricity takes place, is untenable.

Clausius assumes that the molecules in the liquid stored with energy, move with varying velocities; that collisions will occur which may cause the separation of the molecules into atomic groups for a short time; that during the period of separation these groups charged with opposite kinds of electricity peculiar to the groups will, under the influence of the electrode, be directed towards the electrodes in their path and thus become carriers of electricity; he ascribes to the liquid the conditions of dissociation due to fortuitous impacts always occurring, whether the solution be under the influence of external electrical forces or not; that the function of the electric forces is but directive, the effect being, the disturbance of the internal kinetic equilibrium.

The principle of the conservation of energy, developed and applied in thermodynamic relations, influenced the manner of looking upon and interpreting electrochemical processes. The most prominent names associated with the application of this great principle are Joule, Helmholtz, Willard Gibbs, Thomson, Boscha, Favre and others. Much attention was now given to the problem: What is the cause of the electromotive force? The distribution of the energy in the electric circuit, including battery, electrolytic cell and conductors, was investigated in the light of the energy concept and attacked from the mathematical or dynamical side. Weaknesses in older theories were glaringly revealed if searched in the light of this principle. The dependence of the electromotive force upon the entropy term in the equations was shown, and its consequent variation with temperature.

The contributions of Willard Gibbs in this field are the most important, though scarcely appreciated; published in the Transactions of the Connecticut Academy, 1876–78, they were not very accessible and not generally known. This great work anticipated the many discoveries since made experimentally, in a manner all but final in its comprehensiveness and completeness, opened out and suggested experimental investigations only partially undertaken and beginning to be carried out to-day. Why it was and is not more fully appreciated is probably due to its concentration; in the compass of some 300 pages and in 700 equations the entire subject of molecular dynamics is treated. The treatise was too rich to be grasped in its day; it is only beginning to be properly estimated twenty years after its first appearance.

About 1853 Hittorf quantitatively investigated, with great care, the change of con-

centration in solutions of electrolytes about the electrodes when a current passes. This phenomenon had been noticed and studied to some extent by Daniell and others, without, however, having been made use of in explaining the nature of electrolytic action. Hittorf's studies and conclusion bring us into the very midst of the modern views of electrolysis. Taking a simple case, let two electrodes of copper be placed vertically over one another in a solution of copper sulphate, pass a current through the cell making the lower plate the anode; no very noticeable change occurs other than that copper is dissolved at the anode and deposited at the kathode; if after the current has passed for a short time it is interrupted and the electrode short circuited through a galvanometer, a current will for a short time flow in the cell from kathode to anode, that is, in a direction opposite to the one which has passed through in electrolyzing. The counter-electromotive force in this case can not result from polarization at the electrodes, for no change has been brought about at their surfaces, such as a gas deposit in the case of decomposition in acidulated water with platinum electrodes. If the electrolyzing current be continued for some time it will be seen that the solution about the anode has become more concentrated and more dilute about the kathode; the total quantity of copper salt in the solution having, however, remained the same, the counter-electromotive force above referred to is due to this change in concentration.

Hittorf, from 1853 to 1859, examined in a most careful manner the behavior of many electrolytes, and by a series of analyses of the solutions determined this change of concentration due to the passage of the current. His patient labor has only within the last few years received proper recognition.

All theories which so far had survived the test, conceived that the electricity was conveyed by a migration of particles, called ions by Faraday; whether these particles received their changes by contact with the electrodes or contained definite inherent quantities of electricity, the charges being the same for all ions, need not be considered at this time.

The first step toward the decisive establishment of the fact of the migration of the ions towards the plate would be an experimental measurement of the rate of migration; this was accomplished by Hittorf and led to the enunciation of these laws:

1. The change in concentration due to current, is determined by the motion which the ions have in the unchanged solution.

2. The unlike ions must have different velocities to produce such change in concentration.

3. The numbers which express ionic velocities mean the relative distance through which the ions move between the salt molecules, or express their relative velocities in reference to the solution, the change in concentration being a function of the relative ionic velocities. Hittorf's analyses enabled him to give their numerical values. A great many such have been made by him, Nernst, Loeb and others; these results show that in dilute solutions the relative velocities of the ions are independent of the difference in potential between the electrodes (if the current be steady), and that they are only slightly affected by temperature.

Hittorf points out that a knowledge of the specific resistance of electrolytes should give valuable information in reference to the nature of electrolytic action. Horsford, Wiedemann and Beez made such measurements; their methods were, however, imperfect; it remained for P. Kohlrausch to devise a method, using an alternating current, by means of which accurate results were obtained. Kohlrausch's work shows

an amount of patience and experimental skill rarely found; his contributions will remain classical. In connection with Hittorf's work, Kohlrausch recognized that, according to Faraday's law, the conductivity should be represented by sums of the velocities of the ions, each carrying its electric charge. Thus, having from experimental data on conduction the sum of the velocities, and from Hittorf's migration constants, based upon changes in concentration, the ratio of the ionic velocities, the absolute velocities of the ions would be calculable. Inasmuch as the quantities he was to deal with were groups of atoms or molecules he determined at once to make the molecule his unit of quantity, and not mass alone. This expedient simplified the comparison of results and has been neglected by physicists. The comparison of results obtained by making the molecule the unit, revealed at a glance relations between the physical behavior of different substances which would have been obscure if the mass had been chosen as unit. The selection of the most convenient proper unit is of great importance in the interpretation of results and the enunciation of physical laws.

Kohlrausch expressed the concentration in *gramme molecules* per unit volume of solution, the unit solution containing a number of grammes of the electrolyte equal to the number expressing the chemical equivalent on the hydrogen scale, in one litre of water. The measurements were then made upon solutions, the relative numbers of molecules in which were known. The ratio between the conductivity and the number of gramme molecules contained in the solution will then give molecular conductivities.

The results of such measurements show, that as dilution increases there is an increase in molecular conductivity, that in very dilute solutions it approximates a limiting value. This increase of conductivity is considerable for bad conductors, less so for good conductors. The limiting value in dilute solutions of good conductors can be reached. In bad conductors, even at the extremest dilution accessible to measurement, the molecular conductivity is still far from the limiting value.

In general there is an increase of conductivity with increase of temperature, usually amounting to about 2 per cent. per degree Centigrade.

The conductivity of equivalent quantities of neutral salts is of much the same order of magnitude, usually reaching the limiting value at a dilution of $\frac{1}{2000}$ gramme equivalent.

From Kohlrausch's numerical values and Hittorf's constants, the absolute velocity of a large number of ions was calculated. It appears from this, that the velocity of the ion in very dilute solutions depends only upon its own nature and not upon the nature of the ions with which it may have been associated; thus the velocity of the Chlorine ion was found to be the same whether determined from solutions of KCl, NaCl, HCl, etc.

This important general law was also found, that the conductivities of neutral salts are additively composed of two values, one depending only upon the metal or positive ion, the other upon the acid radical or negative ion. According to this law the conductivity of a neutral salt can be calculated from a knowledge of the velocities of the ions independently, a test which has been applied in many cases with very satisfactory results when checked experimentally. For quite a number of compounds, however, the computed results were much too high an abnormality to be discussed later. This law confirms the idea of independent migration of the ions.

Kohlrausch's numbers expressing velocities were checked by some exceedingly ingenious experiments by Oliver Lodge and Wethan. By a change in the color of the

solution of two layers the migration of the ions could be directly measured, these results agree surprisingly well with Kohlrausch's, considering the widely different conditions and the difficulty of measurement.

About 1887 electro-chemistry entered into a new stage of progress; the central figure among those who were mainly active in bringing about this development was Svante Arrhenius, who, together with Ostwald and others, advanced a theory of electrolytic action, explaining very satisfactorily many well-known phenomena. Arrhenius' theory involves the general idea contained in the theory of Clausius and Williamson, namely, that the solution contains the electrolyte dissociated into ions before the current is forced through it. Arrhenius adds that this dissociation is affected by solution or fusion, and that the ions contain charges of positive and negative electricity dependent upon their nature, but of equal quantity in every ion. While in this state, that is, as ions, they move in an irregular manner between the molecules of the solvent and the undissociated molecules of the electrolyte, now attaching themselves to one another and again separating, upon the whole maintaining a condition of Kinetic equilibrium. As soon as brought under the influence of the electrodes of different potential, they are impelled in definite directions, the anions towards the anode, the kathions towards the kathode.

The first work done by the current is the overcoming of the viscous resistances of the medium, not an inconsiderable amount; thus a portion of the energy of the current is fritted into heat.

At the electrodes another kind of work has to be done; either the charges have to be removed from the ions, changing them into the molecular condition, or new ions must be produced from the material of the electrode and the solvent, for kathions arriving the formation of anions or for anions kathions.

Undissociated molecules of the electrolyte take no part directly in electrolysis, except in so far as they may alter the viscous resistance of the solution.

The fact that molecular conductivity increases with dilution means, that as infinite dilution is approached complete dissociation or ionization of the electrolyte is effected.

The ratio between molecular conductivity at greater concentration and infinite dilution, expresses the degree of dissociation or ionization. The conductivity can always be expressed by the sum of the velocities of the ions into a coefficient expressive of the degree of dissociation: $C=A(u+v)$. In the limiting case $A=1$ and the conductivity is measured by the sum of the ionic velocities, this in accord with Kohlrausch's law.

One of the important points in this theory is that solution effects dissociation. Chemically pure substances, such as HCl in the liquid state, should not be electrolyzed; such is found to be the case. The curious fact that pure HCl and pure water alone are non-conductors, but become electrolytic conductors when mixed, is not rationally explained, other than that dissociation results. Why it takes place we do not know; that some change in the associated energy always takes place we do know. In general, unless some chemical change occurs, solution is accompanied by refrigeration, except in the case of gases. It is probable, then, that some of the heat energy taken from the mixture is concerned in this dissociation.

In the case of fused substances heat may be a considerable factor in dissociation.

The question whence come the electric charges upon the ions is not solved. Whether they are inherent in the molecule and become free by ionization or whether

they result from the work done upon the molecules in dissociation is not known. Some progress has been made towards the solution of the question by Ostwald, who succeeded in measuring the heat energy of ionization in a few cases. This problem is one that should be carefully studied.

An objection to the theory of the existence of free ions in a solution has been urged from the chemical side, namely, that the ions possess different properties from the atoms, or atomic groups. It seemed remarkable that a potassium ion should be capable of existing in water without combining with the oxygen, as would be the case in the ordinary atomic or molecular condition. If we consider, however, that the amount of associated energy in the two conditions is different, it is not difficult to imagine different properties. We know, for instance, that negatively charged zinc will not act on hydrochloric acid; that several elements exist in well-known allotropic conditions, showing quite different properties. We explain this by different amounts of associated energy, which, in some cases, is quite measurable.

The difficulty of applying Ohm's law in the case of Grotthus' and Faraday's theories disappears in case of the dissociation theory; it rather becomes a necessary consequence of it.

Considering now a few phenomena not directly involved in electrolysis, evidence in favor of the dissociation theory may be found.

Substances form solutions when a homogeneous mixture results, the constituents of which can not be separated by mechanical means, the proportion between the parts being continuously variable between certain limits, with a corresponding continuous variation in properties.

According to the state of aggregation of the dissolved substance before solution, energy changes usually become apparent, either in temperature changes, contraction of the volume, or the like, when solution is affected. As a rule, such energy changes occur in the same sense when solutions of different concentrations are mixed, until a point is reached, with very dilute solutions, when they no longer are observable. The substance in the solution is then very small in amount as compared with the solvent.

It is a well-known fact that when solutions of different concentration are carefully superposed, the molecules of the dissolved substance pass from the more concentrated to the more dilute solution, until finally a uniform degree of concentration is attained, when a condition of kinetic equilibrium is maintained. This diffusion phenomenon in liquids is similar to that in gases, only it progresses much slower. In the case of gases the dynamics of the process is pretty well understood and satisfactorily explained by the kinetic theory, the mixture of the gases resulting from the projectile energy of the molecules. In the case of liquids it has been variously explained; in general, however, the molecular attraction between the solvent and the dissolved substance has been assumed as the cause. Van't Hoff has recently offered an explanation along the same kinetic lines so satisfactorily applied in gases. The force tending to produce diffusion must be measurable as a pressure, if it exist; if then, the two solutions are separated by a semi-permeable membrane which will allow but one of the two constituents to pass, this pressure will become measurable upon the membrane. The production of such semi-permeable septa is a matter of very great difficulty, but has been accomplished to a very perfect degree for some substances. The general method of making such measurements is familiar to all physicists. Traube, Pfeffer, De Vries, Tammen and Pringsheim, from 1867 to 1885, have succeeded in producing semi-permeable membranes of great perfection,

and with improved apparatus have made many measurements of very satisfactory character. These results show, that equimolecular solutions of non-electrolytes show equal osmotic pressures. The osmotic pressure is directly proportional to concentration (expressed in gramme equivalents). The osmotic pressure is proportional to the absolute temperature.

The similarity of these laws to those of gaseous pressure, is at once apparent. Van't Hoff further, upon the bases of absolute measurements and the applications of the ordinary equations for properties of gases, enunciates the laws: That the molecules of the dissolved substance exert pressures in osmotic action, equal to the pressure which would be exerted by the same number of molecules in the gaseous state upon the sides of a containing vessel of the volume of the solution, the temperature remaining the same.

Osmotic pressure seems then to be merely a molecular kinetic effect. On this assumption thermodynamic considerations led to the same result as experiment.

The first two laws of osmotic pressure could be satisfactorily explained under the ordinary supposition of molecular attraction; the last two, however, are difficult to reconcile with any explanation other than the one that the pressure is due to molecular impact.

The osmotic pressure of electrolytes is considerably greater than that of non-electrolytes; in dilute solutions they, however, follow the same laws of variation. In quite a number of binary compounds it is just twice as great numerically as in the non-electrolytes. The behavior is, as though the number of molecules contained in the electrolyte solution per gramme equivalent, was greater than in non-electrolytes. If we imagine that solution has dissociated the molecule into two groups, the anomaly is easily explained. There is evidence here, independent of electrolytic behavior, that electrolytes are dissociated in solution.

Blagden, as early as 1788, recognized that salts in solution lowered the freezing point of water; his experiments were made mainly on sea water. He found that in very dilute solutions, the lowering of the freezing point was very nearly proportionate to the amount of substance dissolved. Riedorf, Coppett and Raoult carefully studied the subject and found that the molecular depression of the freezing point was equal for salts of similar composition. For non-electrolytes, equimolecular solutions of different salts gave very nearly the same values, showing, that the effect was purely a molecular one independent of the nature of the substance.

The problem may be treated from the dynamical point of view upon this supposition: Knowing the osmotic pressure and imagining the change in state in the nature of a reversible cycle, the necessary energy changes are calculable. The depression of the freezing point calculated in this way for a number of substances gave values closely agreeing with experiment. The evidence that this effect is purely a molecular kinetic process is very strong.

Electrolytes cause a depression of the freezing point, experimentally determined, far greater than non-electrolytes; we have here another evidence of dissociation by solution.

The investigation of the effect of substances in solution upon vapor pressure and boiling point made by Berthelot, Beckmann, Raoult, Ciamician, Ostwald and others lead to precisely similar laws.

We may summarize these laws thus: Equimolecular solutions of different substances made with equal masses of the same solvent, show equal osmotic pressure, equal relative diminution of vapor pressure, equal elevation of boiling point and equal depression of the freezing point.

Electrolytes give greater values than non-electrolytes. The effect is as though there was present a greater number of molecules than indicated by the amount of substance dissolved. Binary compounds in dilute solutions, give nearly twice the numerical values found in solutions of non-electrolytes.

From these experimental results the theory of dissociation of electrolytes by solution and the electrolytic conduction by directing the migrating ions seems very strong.

Chemical evidence can not be reviewed here; the evidence is, however, fully as strong or even stronger than that considered.

Reversing the phenomena of electrolytic decomposition, Nernst applies these concepts to the battery problem. We will apply the theory to one or two simple cases only.

When two solutions of the same electrolyte are brought in contact electrical differences manifest themselves. The mere statement, that the cause for such difference in potential is contact, is unsatisfactory. Nernst reasons in this wise: The ions in virtue of osmotic pressure will diffuse; migrating with different velocities, as shown by Hittorf, they will diffuse at different rates; there will result, therefore, an excess of anions in the one solution and kathions in the other; the ions possessing characteristic electric charges, there will be found an excess of positive electricity in the one solution and an accumulation of negative electricity in the other solution. If an indifferent electrode be immersed in each solution, connected through a conducting circuit, there must result a current. We have here a battery giving an electrical current as a result of osmotic pressure. The necessary conditions for the production of the current are, that the ions have different velocities and exert osmotic pressure; that in solution we have the molecules dissociated or ionized; that the energy associated if current flows, is less at the close of the operation than at the beginning.

Nernst and Helmholtz calculated the electromotive force for such cells from the experimental data of osmotic pressure and ionic velocities, obtaining results agreeing very well with electrical measurements.

It would, perhaps, be expected from the above that the current would continue until the concentration had become uniform; such, however, will not be the case in the battery just described, for the kathions at the kathode and the anions at the anode will now develop electrostatic attractions which can not be overcome by the electromotive force of the battery.

Modifying the cell so that, in place of indifferent electrodes, we use electrodes of the metal, the salt solutions of which surround it, a battery results which will continue in operation until uniform concentration results. In this case the kathions will, at the kathode, by giving up their electric charges, become metallic, the electrode becoming positively charged; at the anode metallic particles will go into solution as kathions. This ionization involves energy changes. The kathions there produced, carrying positive charges with them, leave the electrode negatively charged.

In a battery, such as described, three differences of potential result; one at the surfaces of the solutions differing in concentration, and a difference of potential between the surfaces of the electrodes and the solution, the first having been explained as originating from osmotic pressure. Nernst explains the latter as resulting from a solution pressure. Just as a liquid evaporates from the surface until the vapor pressure becomes equal to the vaporization tension, so in solution will a salt dissolve until the osmotic pressure becomes equal to the solution tension of the salt. In the same way Nernst supposes that each metal has a tendency to convert atoms of the

metal into ions in solution as soon as it is immersed in an electrolyte; this has been termed electrolytic solution tension. Osmotic pressure and solution tension thus become analogous concepts. Three conditions are possible in the battery cell:

1. If the solution tension be greater than the osmotic pressure the metallic plate acts like a salt mass in a dilute solution. Kathions will be thrown into the solution positively charged, leaving an equal negative charge upon the electrode; at the surface of separation between solution and electrode we shall have positive kathions upon one side and negatively charged metal upon the other, these exerting electrical forces, a condition will be reached when they are equal to the solution tension, further action will then cease until the kathions are discharged or made metallic.

2. If the osmotic and solution pressures are equal, no difference in potential will result; as when a mass of salt is introduced into a saturated solution, of itself no change takes place in equilibrium.

3. When the osmotic pressure is greater than the solution tension, kathions will be projected upon the plate and made metallic, the electrode becoming positively charged and the solution negatively, similar to the action which takes place when a solid salt is brought into contact with a supersaturated solution where salt particles will be deposited.

The determination of the relative values of solution pressures is comparatively simple, the determination of their absolute values very difficult. In the case of mercury and a saturated solution of calcium chloride, the absolute value has been determined with considerable accuracy from the effect upon tension phenomena in the mercury surface, fully discussed by Lippman, Helmholtz and Paschen. Ostwald and Planke obtained, values by two methods based upon this action agreeing very well. With this value as a basis others have been determined. Applying those values experimentally obtained, together with the ones for osmotic pressure, in calculating the electromotive force of a number of well-known cells, an excellent agreement with experimentally determined values is found.

It will be impossible in this review to apply these theories to the various forms of batteries known, and to many phenomena of electrolysis which we have no space even to mention; the theories briefly reviewed have borne rich fruit in the more satisfactory explanation of electrolytic action. Many problems still remain to be attacked, while some have been but now appreciated.

The development of the solution and dissociation theories gives no explanation of the forces and conditions which cause solution or ionization, though some attempts have been made in this direction. Thus, J. J. Thomson has shown that if the attractions between the ions in the molecule is due to electrical forces it will be weakened, if the molecules be immersed in a medium of high specific inductive capacity. Experimental evidence, in so far as it goes, shows that in liquids of high specific inductive capacity, ionization is most complete. This is one of the problems to be systematically studied.

With the solution of the older problems new ones present themselves. This is the effect of any comprehensive good theory. Many new problems in molecular physics and electrolysis are suggested through Arrhenius's, Van't Hoff's and Nernst's theories. Their development and solution will not be one of chance, however, to be stumbled upon by daring or blind groping, but by intelligent, painstaking research. A bird's-eye view of the field is given us through these theories, in filling in the detail and contours, the chance explorer must give way to the systematic investigator.

Until within the last three or four years,

the systematic and careful amassing of experimental data for building up or verifying these theories, was done by a few European workers, mostly chemists; since Willard Gibbs's theoretical work bearing upon this subject, scarcely a single addition of importance has come from American workers; in fact, it seems that much of the work done abroad is scarcely known to American physicists. It is to be regretted that in the history of the development of this branch of electrical science hardly an American name will appear.

There, however, remains much to be done, and contributions from this side will I trust be made.

Whether electrolytic action ever occurs in solids, is a question which I do not believe has been definitely settled. If such action ever does take place, the theories just considered will have to be modified. Some very curious phenomena in glass, subjected to the action of the electric currents, have been noticed; the claim has been made that glass has actually been electrolyzed, though the evidence so far is not conclusive. The very interesting changes of conductivity with variation in temperature, exhaustively studied by Thomas Gray, indicate molecular changes which may be due to dissociation. The form of the equation for change in conductivity with temperature shows a maximum with reversal, considerably below the fusing point. A similar peculiarity is noticed in alloys. The systematic study of this seems important.

Careful study of heat absorption when salts are dissolved should be made. Much work has been done in this direction. A careful examination and comparison of results, however, convinces one that the methods and manner of conducting the investigation must have been widely different, for the results vary in a most astonishing manner; at any rate, definite conclusions cannot be based upon them. If ionization requires energy, it is more than likely that some will be taken from the solution in the form of heat. In very dilute solutions dissociation of the electrolyte seems complete, while in concentrated solutions it is incomplete. A careful determination of the heat absorption per molecule, when the salt is dissolved in concentrated or dilute solutions, might give valuable results. The problem is very complicated, yet it should be attacked.

That gases can conduct electrolytically seems fairly certain. This field is scarcely entered and may well be studied.

The peculiar behavior of charged plates under the influence of violet light seems likely to involve electrolytic action and bear upon dissociation questions.

So multitudes of problems suggest themselves, the study of which may tend to crystallize the theories of dissociation and solution, so promising at this time, into more perfect form. It can scarcely be doubted that the remarkable connection, evident when the phenomena of solution, modification of freezing and boiling point, osmotic pressure, optical rotation, chemical equilibrium and stability, metathetical reaction, thermal neutrality, electrical conductivity and electrolysis are considered, taking the molecular equivalent mass as the unit, indicates a very near relationship of these processes. The power of Arrhenius's dissociation theory, Van't Hoff's solution theory, together with the conceptions of Hittorf, Clausius, Nernst and Ostwald in explaining the dynamics of molecular action, is most promising. Whether more accurate and more plentiful quantitative studies of these so closely related phenomena will lead to closer concordance or greater divergence of the numerical values obtained, and thus strengthen or reveal weaknesses in the theories, must remain to be seen.

These theories, if fastened, will have a marked influence both upon the chemical

and physical conceptions of the structure of complex molecules. They seem to demand essentially a condition of kinetic equilibrium between molecules and atoms; inter-atomic distances we shall have to consider greater than was our wont; atomic and molecular influences must extend to considerable distances. Geometrical static arrangement of atoms or groups of atoms seems incompatible with their behavior. The relation of atoms in the molecule seems rather to be orbital, permitting of ready rearrangement and readjustment by relatively slight disturbing causes, capable of returning to former relations promptly, involving various quantities of energy. All our inferences in reference to molecular magnitudes will have to be interpreted as effective merely, and not actual in the sense of space occupied.

The one central pillar upon and about which all physical science is erected to-day, the conservation of energy, stands unchanged and, if possible, more clearly defined and strengthened than ever in these tests.

I repeat, may American physicists take up these problems and add their share to the development of these epoch-making theories.

C. L. Mees.

Rose Polytechnic Institute,
Terre Haute, Ind.

THE CORNELL EXPEDITION TO GREENLAND.

The Cornell party, which accompanied Lieut. Peary on the steamer Hope, left Sydney, July 16th, and passed the entire eastern coast of Labrador near the land, with one stop at the island of Turnavik. Entering Hudson Strait a stop of several days was made at Big Island and the neighboring coast of Baffin Land. From here an unsuccessful attempt was made to penetrate the ice which stretched across the mouth of the Cumberland Sound, after which the ship steamed across to Disco Island, on the Greenland coast. A stop was made there, another in the Vaigat Strait and a third at Umanak. After a brief stop at Upernavik, the party was landed, August 7th, on the Nugsuak peninsula, Latitude 74 °7′, about 80 miles north of Upernavik. The party remained there until September 7th, and then returned, following practically the same route and making nearly the same stops as those made on the northern passage on the Greenland coast. On the American side a stop of two or three days was made in Cumberland Sound, where the conditions closely resemble those in Hudson Strait.

The main object of the expedition was to study the geology of a small area in some detail; but collections of plants, insects, marine invertebrates and birds were also made. In connection with this work considerable dredging was done.

Briefly stated, the principal geological results are as follows: At Turnavik, on the Labrador coast, evidence of recent glaciation is abundant. The hills are all rounded; there has been little post-glacial decay, and the transported boulders, as well as the bed rock, are very fresh. Upon exposed rock faces, unprotected from the weather, glacial striæ are still very distinct. Granting equality of weathering, this region has been much more recently glaciated than regions of similar geological structure in New England. The amount of glacial carving has not been sufficient to lower the surface of the gneiss to the level of the pre-glacial decay in the trap-dike valleys.

Until the northern end of the Labrador peninsula is approached evidence of glaciation in the form of rounded contours is so distinct that it may be seen from a ship several miles from land. At Cape Mugford, Table Mountain and vicinity, in Latitude 58° 59′, the topography changes to the angular type, and this highland portion of the

narrow northern prolongation of Labrador may have risen above the ice. Later experience in Greenland, however, has led me to place little coufidence in evidence of this sort. Rounded contours are positive evidence of value, but the negative evidence of angular outline is of little value, particularly when combined with considerable elevation. The rate of weathering and erosion on some classes of rock in high latitudes is extraordinary ; and if, as is so often the case in Greenland, the glaciation did not suffice to greatly modify the pre-glacial topography, the combination of pre-glacial and post-glacial denudation serves to abundantly mask the evidence of glaciation when the hills are viewed from a distance.

That part of Baffin Land bordering Hudson Strait in longitude 70°–71° has all been glaciated up to an elevation of at least 600 feet. The evidence of this is found in indistinct striæ, an abundance of transported fragments of limestone, and other foreign rocks, and the roches moutonneés form of the rock outcrops. The garnetiferous gneiss and crystalline limestone of the region have been markedly disintegrated since the retreat of the ice sheet ; and yet the recency of this retreat is shown by the freshness of some of the rocks and also by the fact that some of the lakes have two outlets, while one was seen with five outlets.

Both at Big Island and on the main Baffin Land evidence of very recent elevation is found to a height of 270 feet above the sea. The evidence of this is present in the form of a series of perfect boulder beaches, one above the other, marking various halts. In a muddy gravel, at an elevation of 270 feet, an abundance of Saxicava, Mya and other shells was found. A depression to this amount would lower a very considerable area of the border of this part of Baffin Land.

The results of the study on the Nugsuak peninsula will be more fully described elsewhere. At the southeastern base of the peninsula there is a large glacier which is given the name Cornell glacier and on the northern side is the Wyckoff glacier.* The latter is nearly stagnant and enters a narrow fjord from which the winter floe ice did not escape during the summer. The Cornell glacier is active, but not nearly so much so as some of the glaciers south of it. This is shown not by actual measurements of the rate of motion, but by the quantity of the bergs which are discharged. For various reasons, mainly because of the roughness of the ice surface and the lateness of the season, no determination of the rate of movement of the Cornell glacier was attempted. On the Nugsuak peninsula there are several glaciers ranging from mere snow fields to a glacier of the valley type which just reaches the sea.

The Nugsuak peninsula extends 24 miles from the front of the Cornell glacier to the end at Wilcox Head. To seaward at a distance of 8–10 miles from Wilcox Head lie the Duck Islands, one of which rises to an elevation of 110 feet above the sea, while the other attains an elevation of 200 or 300 feet. The depth of the neighboring sea is in some places over 100 fathoms.† The highest point on the Nugsuak peninsula is 2,500 feet and in many places its elevation is over 1,000 feet. At Wilcox Head the elevation is 1,400 feet and the sea near by more than 100 fathoms in depth. The rocks are all gneiss crossed by numerous trap dikes, the gneiss being apparently a metamorphosed sedimentary series faulted and folded with great complexity.

A retreat and advance of the Cornell glacier at some recent time is proved by the presence of fragments and entire shells of

*Named after Mr. E. G. Wyckoff, who generously furnished the money needed for the expedition.

† Based upon a sounding made about half way between Wilcox Head and the Duck Islands, which gave 114 fathoms, and upon the fact that bergs from 75 to 100 feet above the water pass through the channel.

Saxicava, etc., in the moraine now being constructed as well as in the ice itself. These occur at all elevations from sea level to 600 feet, but the configuration of the region is such that this may not mean a retreat of more than one or two miles.

Notwithstanding this retreat and advance, the glacier is now engaged in a rapid withdrawal. The evidence of this is found in moraines 100 or 200 feet from the ice front, in some of which an ice core still exists, while in all cases the withdrawal has been so recent that the boulders have not become lichen-covered. The same is true of the bed rock between the moraines and the ice.

This very recent retreat is a part of a general withdrawal of a vast ice sheet, which extended outward beyond the Duck Islands, a distance of no less than 32 miles from the front of the Cornell glacier. The entire Nugsuak peninsula has been so recently glaciated that striated rocks are still present even at the outer end. Boulders of slate, quartzite and porphyritic granite-rocks, nowhere found in place on the Nugsuak, occur abundantly in the moraine of the glacier and are strewn over the peninsula. The granite was also found on the Duck Islands in a bed of till. At the Devil's Thumb, which rises 2,600 feet above the sea, transported blocks of the granite were found, and they are abundant at the top of the highland of Wilcox Head, 1,400 feet above the sea. Therefore, granting a depth of no more than 100 fathoms for the fjord south of the Nugsuak, there has recently been an ice sheet here covering all of the land and having a depth of no less than 2,000 feet, and probably much more. At the Duck Islands, 8–10 miles farther from the mainland, and 32–34 miles from the present ice front, the ice sheet had a depth of no less than 800 feet, and probably much more.

So, in this part of Greenland at least, the present glaciation is a shrunken remnant of a former greater sheet, the western limits of which cannot be drawn. At Disco Island, at an elevation of 2,000 feet, gneiss boulders rest on trap; and, while they *may* have been brought from within the island, it is equally possible that they were brought from the direction of the mainland. It will be an interesting point to decide how extensive this greater glaciation has been. It seems hardly probable that it was local.

Various detailed observations were made along the margin of the glacier and upon the direction of movement in the ice as well as of the ice over the peninsula. One of the most marked features noticed is the remarkable control which topography has upon ice movement, especially in the last stages of the ice. In one case the movement of an ice tongue of the main ice cap is moving in exactly the opposite direction from the general movement of the ice which supplies it. The general movement is one thing, the deviation from this induced by larger topographic features is quite another, and the influence of minor topographic features in the very last stages is still another; but while one gains much in the way of valuable hints from a study of the Greenland ice sheet, he must needs be very cautious in his application of these to our own recent glaciation. The conditions are very different, and in no way is this more markedly shown them in the decided poverty of drift in the control of the Greenland ice.

The thanks of all connected with the expedition are due to Lieut. Peary for the sagacity with which his plans were laid and executed. The terrors of Arctic navigation, of which we have all learned so much, do not appear in his summer trips; and, judging by this summer and the several preceding ones, an expedition to Greenland under the lead of Lieut. Peary is as safe and pleasant a summer excursion as one to Alaska. The expedition went and returned on schedule time, and this has been

his previous experience. It is one constant panorama of wonderful scenes, with land nearly always in sight, often on both sides, and with the water ordinarily as calm as the surface of a small inland lake. The fact that all who go wish to go again in the best evidence that can be offered of the great attractions offered by Greenland to the geologist and naturalist. I feel that this statement is warranted because it is so greatly at variance with the common conception of Greenland and the southern Arctic.

RALPH S. TARR.
CORNELL UNIVERSITY.

ALBERT NELSON PRENTISS.

PROF. ALBERT NELSON PRENTISS, who for twenty-eight years has occupied the chair of botany in Cornell University, died at his home on the University Campus, Friday, August 15, 1896. He had been in failing health for several years, and the readers of SCIENCE will recollect that last February severe illness induced him to ask to be retired from active labor in the department, and the Board of Trustees elected him professor emeritus.

Prof. Prentiss was born May 22, 1836, at Cazenovia, Madison County, N. Y. He was a member of the first graduating class of the Michigan Agricultural College, at Lansing, in 1861, and the entire class of seven young men immediately enlisted in the army at the outbreak of the Civil War. He was enlisted in the Signal Service Corps at Battle Creek, Mich., and assigned to special signal service duty in the interior of Missouri. His connection with the army was of short duration, owing to a reorganization on the retirement of the commanding general. In 1862–63 he was associate principal of the Kalamazoo, Mich., high school, and in 1863–64 was instructor in botany and horticulture at his *alma mater* the Michigan Agricultural College, receiving the degree of M. S. in 1864. He was promoted to the professorship of botany and horticulture in 1865, and held this place until called to the professorship of botany, arboriculture and horticulture in Cornell University, at the opening of the University, in the autumn of 1868. He entered upon his work in this new field with enthusiasm and planted the first autumn seeds of a number of species of trees for a nursery to provide trees for beautifying the grounds. Many of these trees were transplanted in various parts of the campus, but the rapid growth of the University has called for their displacement to provide room for buildings, so that now but three pine trees remain of this original nursery, which are of the same age as the University.

Prof. Prentiss' work has been given largely to teaching and to the supervision of the large grounds of the University, and there are not many published papers of his. In 1871 he wrote an essay on the 'mode of the natural distribution of plants over the surface of the earth,' which won the first Walker prize offered by the Boston Society of Natural History, and was published in pamphlet form. Later, at the request of Prof. B. E. Fernow, Chief of the Division of Forestry, U. S. Department of Agriculture, he prepared an extended monograph of the hemlock (*Tsuga canadensis*), that has not yet been published.

In 1872 he studied for six months in the Royal Botanic Garden at Kew, London, and in the Jardin des Plantes, Paris.

Prof. Prentiss was one of the members of the 'Cornell Exploring Expedition,' as it usually is called, which was organized by Prof. C. F. Hartt, the then professor of geology in Cornell. This expedition was made possible largely by the generous gift of funds by the Hon. Edwin Barber Morgan, of Aurora, N. Y., and is known in University history as the 'Morgan Expedition.' The party sailed from New York

the latter part of June, 1870, explored the valley of the Amazon for a distance of about 400 miles above Pará, as well as the rivers Chingu and Tapazos, two of the principal tributaries of the Amazon. Prof. Prentiss thus had an opportunity of studying the tropical flora, and of making collections for the department. The party returned early in January, 1871. Among the large number of students who have received instruction from him, many have become botanists or teachers of botany, and a noteworthy list of names of these persons might be presented, several of whom occupy some of the most prominent botanical positions in America. In his lectures he was deliberate, clear and concise in his statement, and an easy and fluent speaker. His dignified bearing led many at first to regard him as unsympathetic, but those who came to know him well regarded him as a most delightful companion.

His keen interest in the work of the individual student, and his well chosen words of approval and encouragment kindled enthusiasm among his pupils, and stimulated them to renewed effort. The same gentle and elevating influence, with his cultivated and refined taste, exerted upon his pupils, also was felt in his home and in his social life, and it is to be regretted that the lack of a strong constitution and reserve power, coupled with failing health for a number of years, prevented the production of work and publications which otherwise might have been expected of a man who possessed such culture and natural gifts.

Geo. F. Atkinson.
Cornell University.

CURRENT NOTES ON PHYSIOGRAPHY.

WATERWAYS OF ENGLISH LAKELAND.

Under the above title J. E. Marr discusses the origin of the river courses in the lake district of northwestern England (London Geogr. Journ, vii., 1896, 602–621). The chief streams are thought to have been superposed on the deformed paleozoic rocks of the region from an unconformable cover of the younger strata; Marr advocating the former occurrence here of Cretaceous or even of Eocene beds. Subordinate streams are subsequent, being developed along weak strata or along faulted belts. The lake basins, large and small, are not explained by glacial erosion, but by drift barriers; fuller evidence on this point being promised. The gradual retreat of the Pennine escarpment, and the beheading of the Tees headwaters by the steep 'gills' that descend to the Vale of Eden, are incidentally described.

In certain paragraphs there does not appear to be sufficient appreciation of the long perspective of events involved in the history of so old a region as Lakeland. The upper part of river Lune, flowing from carboniferous rocks to the higher-standing paleozoic beds of Howgill fells, is given as an example of antecedent drainage. Several branches of the Lune, that flow from the thrown to the heaved side of the great Dent fault, are likewise explained as antecedent. Here the possibility that many cycles of erosion elapsed since the ancient rocks of the region were deformed and faulted is not clearly set forth. Yet, during these cycles, it is quite possible that the land forms initiated by the ancient deformation, and the river systems antecedent to or consequent upon these land forms, may have suffered extensive alteration; the lands may have been more than once uplifted, dissected and peneplained; they may have been drowned, buried, uplifted and stripped; and the rivers may have lost their initial courses by spontaneous adjustments to internal structures, by superposition, or by displacement through warping of the land surface. The problem is not simple enough to be decided merely by the direction of a stream with respect to the heaved side of a fault.

ORIGIN OF LAKE ZURICH.

THE discussion of this problem by Aeppli has been noticed in SCIENCE. Preller now dissents from some of the conclusions of the Swiss geologists, and maintains that he has identified deposits of 'Deckenschotter' (first glacial epoch) in the trough of the lake valley, and hence that the valley must have attained its present general form by fluviatile erosion before the earliest glacial invasion (Q. J. Geol. Soc. London, lii., 1896, 556–586). He attributes the lake basin to a deformation of the valley, here following Heim and Aeppli. In curious contrast to Geikie and Wallace, who place no value upon such deformation or upon unequal subsidence, Preller allows glacial erosion no share in excavating the lake basin, and does not even present arguments for the exclusion of this important agency. The main points of this essay, the occurrence of 'Deckenschotter' in the deep valley trough, and consequently the great abbreviation of the first interglacial epoch, will doubtless be discussed by Swiss observers on the ground.

DUST AND SAND STORMS.

DUST and sand storms in the western part of the United States are described by J. A. Udden, with special reference to the geological significance of these phenomena (Pop. Sci. Monthly, Sept., 1896). He estimates that the dust in a cubic mile of lower air during a dry storm weighs at least 225 tons; while in severe sand storms the solid contents in the same volume may reach 126,000 tons. At Yuma, Ariz., any high wind, without rain, generally blows clouds of dust. At Ontario, Cal., there are from twelve to forty dust storms in a year. The brief dust squalls in the Eastern States, preceding a thunder storm, are in the arid region replaced by dust storms lasting twenty or thirty hours. One observer gives local color to his phrase: "A strong wind was made thick and yellow by flying real estate."

The physiographic value of the wind in drifting sand is illustrated in an account of the Takla-makan desert, Central Asia, by Sven Hedin (London Geogr. Journ., viii, 1896, 264–278). He finds that shallow lakes occur at the western base of the desert mountains, while the eastern base and slopes of the ranges are encumbered with sand hills, carried by the prevailing northeast or east winds. The widespread sand hills of our western plains were abundantly described by early explorers; for example, Warren, in 1855, '56 and '57, but they are less heard of to-day, when the railroads carry travelers quickly across the plains to the more varied scenery and problems of the mountains.

PHYSICAL GEOGRAPHY OF NEW YORK STATE.

THE American Geographical Society turns attention to home study in an essay by R. S. Tarr under the above title (Bull. A. G. S., xxviii., 1896, 99–129), the first of a promised and welcome series. The State is divided into eight provinces, named Long Island, Gneissic Highland, Taconic, Catskill, New York-Pennsylvania Plateau, Lake Shore Plains, Mohawk Valley and Adirondack; each of these is briefly characterized. The drainage system is then described. The geological development of the state is concisely explained in eight pages, and the essay closes with four pages on climate.

GEOGRAPHY FROM NATURE.

IN the same Bulletin, R. E. Dodge urges the importance of studying 'Geography from Nature' (p. 146–156), and mentions a number of localities near New York city where such study can be undertaken to advantage. Tarr advocates the same method, emphasizing the value of a training in field geology, in an article on the 'Teacher's Outfit in Physical Geography' (School Review, iv., 1896, 161–172, 193–201). With similar intention, the undersigned has prepared

pamphlets on 'The State Map as an aid to the study of Geography in Grammar and High Schools,' published for distribution to all public school teachers by the Boards of Education of Connecticut and Rhode Island.

W. M. Davis.
Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

ORIGIN OF THE ANCIENT INDIAN ALPHABETS.

In the 'Mélanges Charles de Harlez', Prof. Friedrich Müller has an instructive article on the origin of the alphabets of ancient India. These may be traced to two early forms, one known as the Brahmi, the other as the Kharosthi writing. The latter is limited in area to a portion of northwest India, while the former extended in remote times over a much larger territory.

The paper makes it clear that the Karosthi alphabet was introduced under the Achæmenides from Ariana, and hence is comparatively modern; while the Brahmi at some very remote age was derived from the southern Semitic alphabets, and adapted to the needs of the Aryan tongue by the addition of characters for the vowels.

These views are confirmed by the presentation of a comparative table of the Indian with two north Semitic and two south Semitic alphabets. The analogies are well marked, and render it probable that the route of extension was by way of southern Arabia. The early connection of the region with India is also proved by the close relationship of the arts in photo-historic times.

EXPLORATIONS IN YUCATAN.

In number 10 of the current volume of 'Globus,' the experienced traveler Theobert Maler describes briefly the explorations he has made this year in southern Yucatan and along the upper Usumacinta river. They have been unusually productive in bringing to light ruined cities hitherto unknown. He crossed the boundary of Guatemala at Chuntuki, and reached Lake Peten at San Andres. Thence he made an expedition to Tikal, near which he discovered an important site, Motul de San José. Near Saiyanche, he came upon a series of ruins with enormous carved pillars. After visiting several less conspicuous localities he passed a few days in 'Lorillard city,' where he made some interesting finds.

In going by land from there to Tenosique he reached a massive series of pyramids and walls hidden in the forest, known to the hunters as Piedras Negras, but wholly unvisited by Europeans. This site presents an 'acropolis' of stately proportions with many surrounding lesser structures. In front of the temple were seven beautifully carved steles in good preservation. They were carefully cleaned and photographed. The inscriptions were numerous, showing close analogies to those at Palenque. On some the colors were yet distinct. There is a marked difference between the architectural details of this and the ruins on the river above, probably indicating contrast of secondary culture centers. Maler expects to spend the present autumn and winter in continuing these researches.

D. G. Brinton.
University of Pennsylvania.

ASTRONOMICAL NOTES.

The report of Dr. David Gill, Director of the Cape of Good Hope Observatory, upon the Geodetic Survey of South Africa, has been presented to the Cape Parliament. The Survey was executed by Colonel Morris, under the general direction of Dr. Gill. The volume contains about 450 pages, folio, and it will be of the greatest interest to astronomers and geodesists. Especially noteworthy is the great amount of work which has been accomplished in a comparatively short time. Such a record of speed, com-

bined with equal precision, has probably never before been made.

Two theodolites were employed: An eighteen-inch by Troughton & Simms, and a ten-inch by Repsold. Dr. Gill reaches the following conclusions with regard to these two instruments:

1. That the employment of instruments larger and heavier than the Repsold ten-inch is attended with no advantage.

2. That observations should be made at each station equally in the morning and afternoon; if possible, also, in opposite directions of the wind.

3. That hardened steel pivots are essential.

4. That a watch telescope attached to the arms of the circle microscopes not only increases very materially the accuracy of the observations (even when the most rigid stand is employed), but it permits the use of a form of stand which is easy to erect and light and convenient for transport, without risk of diminished accuracy.

Many American geodesists will be surprised by conclusions 3 and 4.

Dr. Gill gives an interesting table of the probable error of a single angle, as obtained in various series of geodetic operations. Some of the values given are as follows:

	No. of Triangles.	Prob. Error.
South Africa, verification of Natal base,	5	±.″14
South Africa, prolongation of Port Elizabeth base,	24	.23
U. S. Coast Survey, San Francisco and Salt Lake,	31	.25
U. S. Coast Survey, flat country,	198	.79
Ordnance Survey of Great Britain,	476	1.19

It is interesting to note that the poorest work was done on the Ordnance Survey of Great Britain, according to Dr. Gill's table.

In Colonel Morris's report we find the following interesting statement concerning transport:

"The equipment of the observing part of the detachment consisted of:

1. A military ambulance wagon, drawn by 16 oxen.

2. An 18-foot buck-wagon, drawn by 16 oxen.

3. A Scotch cart, drawn by six oxen.

4. A water cart, drawn sometimes by two oxen, sometimes by four.

5. The four out-parties were each provided with a Scotch cart drawn by six oxen.

The minimum number of oxen was therefore 66. A few additional animals were, however, always kept to supply the place of those which tired or fell sick, or which died from one cause or another."

We strongly recommend anyone interested in geodesy to procure a copy of Dr. Gill's interesting and important work.

THE *Astronomische Nachrichten* of September 8th contains an article by Dr. J. Repsold, in which he describes the newest micrometer devised by his firm. It is an instrument intended to combine the new form of transit micrometer, in which an effort was made to avoid the effects of personal equation, with a new kind of registering declination micrometer. Dr. Repsold points out that it is very desirable to increase the precision with which declination bisections can be made in the field of view, so as to bring the bisection to the same order of accuracy attainable in the reading of the circle microscopes.

H. J.

NOTES ON INORGANIC CHEMISTRY.

IN the current *Comptes Rendus* P. Villard describes a crystallized hydrate of argon with water. Argon is compressed to 150 atmospheres in the presence of water cooled to nearly zero. On chilling the tube at a small point crystallization begins proceeding out from the point cooled. Or crystallization may be induced by introducing a crystal of the hydrate previously formed. Crystallization does not take place, however, by merely compressing argon in the pres-

ence of cold water. The crystals are colorless and small, though easily visible with a lens. The tension of dissociation at 0° is about 105 atmospheres, at + 8° 210 atmospheres.

An account of the Jubilee of the Chemical Society of London, in 1891, has just been published by the Society in book form. It contains a record of the proceedings of the Jubilee meeting and also a full history of the Society. Abstracts are given of all the presidential annual reports, the subjects of all lectures before the Society, and the full text of the first Faraday Lecture, which was given in 1869 by Dumas, and which had never before been printed in the Society's publications. The whole volume, which includes 292 pages and gives the full history of one of the most important scientific societies of the world, will be found of value to all who are interested in chemistry.

A series of experiments has been carried out by Messrs. Dixon and Baker, having for their object the determination of the chemical activity of the Röntgen rays. Carbon monoxid and oxygen (dry and moist), hydrogen and oxygen, carbon monoxid and chlorin, hydrogen and chlorin, and dry hydrogen and sulfid and sulfur dioxid, were exposed half an hour to the rays; sparks were passed through dry carbon monoxid and oxygen, both with rays falling on the mixture and when they were not. In no case could any chemical effect of the rays be detected, hence the authors conclude that if there is any chemical activity of the rays it is too small to be measured. The action of the rays on the photographic plate they attribute to the fluorescence of the glass behind the film.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

The attendance at the Liverpool Meeting of the British Association was 3,181, distributed as follows: Old life members, 330; new life members, 31; old annual members, 383; new annual members, 139; associates, 1,384; ladies, 873; foreign members, 41. As had been already arranged, the meeting for next year will be at Toronto under the Presidency of Sir John Evans, beginning August 18th. The meeting in 1898 will be at Bristol and in 1899 at Dover. The sum of £1,355 was appropriated in grants for scientific purposes.

In addition to the lecturers in connection with the sesquicentennial celebration at Princeton, already announced, the exercises will be attended by a number of distinguished men of science as delegates from foreign universities. The names have not as yet been published, but include M. Henri Moissan, the eminent chemist from the University at Paris, and Prof. E. B. Poulton, professor of zoology at Oxford, and personally known to many Americans from his previous visit.

We learn from *Die Natur* that elaborate arrangements are being made in Portugal to celebrate the 400th anniversary of Vasco da Gama's discovery of the sea route to India. The 8th, 9th and 10th of July of next year are to be made national holidays and a number of expositions and congresses are to be held at Lisbon, including agriculture, ethnography, fisheries and hydrography. The event will also be celebrated by the Geographical Society of Vienna, before which an address will be made by Prof. Wilh. Tomaschek.

The Jubilee of the discovery of anæsthesia will be celebrated in France in connection with the meeting of the French Surgical Congress beginning October 18th. The event will also be celebrated in London and in Boston. The first surgical operation under ether was carried out by Dr. J. Collins Warren in the Massachusetts General Hospital on October 16, 1846. The anæsthetic was administered by W. T. G. Morton, who about two weeks before had extracted a tooth from a patient under the influence of ether.

It is stated that Lieut. Joseph E. Maxfield, Chief Signal Officer of the Department of the Missouri, and now stationed in Chicago, will soon make an ascent on a man-carrying kite, to be built by Octave Chanute. The ascent will

be made in an arm-chair fastened to a portion of the kite's frame, and will be for the purpose of testing the efficiency of a flying kite for observation purposes, as an adjunct to the balloon service, which for some time has been an important part of the signal corps work.

ALTHOUGH the 300,000 frs. needed for the Belgian expedition to the polar regions has been collected, it was not found possible to make the necessary preparations, and the expedition has been postponed until July of next year.

THE Danish steamship *Inglof* has returned after two years spent in exploring the coast of Iceland. It is stated that scientific results of importance have been secured.

PRESIDENT JORDAN, with the British and American commissioners sent to study the condition of the seals in Behring Sea, has arrived at Seattle and is reported to have said that there is still a vast body of fur seals on the islands, more than the commissioners were first led to expect, but the number is steadily declining. The only cause of this decline is the killing of females through pelagic sealing. The females are never molested on the islands. Pelagic sealing, as an industry, has already cut its own throat, as the fleet this year will not pay expenses. The killing of surplus young males, as provided for by law, has always been a benefit to the herd. The commissioners believe that the way is open to an honorable and amicable settlement of this question in a manner highly satisfactory alike to the United States and England and to Canada. There can be no longer any difference of opinion as to any facts in question.

A DESPATCH to the daily papers from San Diego, Cal., states that the junk *Alta* has arrived from Lower California with Mr. E. A. Anthony, who went there in the interest of the Smithsonian Institution. He brings back a great quantity of shells, mosses and sea flora and natural history specimens, many of them entirely new to naturalists.

DR. DAVIS GARBER, professor of mathematics and astronomy in Muhlenburg College, Allentown, Pa., died on September 22d, aged 67 years.

DR. THEODOR MARGO, lately professor of zoology in the University of Budapest, died on September 6th, at the age of 80 years.

YEN MEN, a commissioner from the Emperor of China, is now in America collecting information regarding American manufactures and methods of transportation. He will also visit the principal countries of Europe.

A LABORATORY built for the Massachusetts General Hospital, Boston, at a cost of over $20,000, will soon be ready for use. The building is 25x97 feet, and includes well fitted laboratories of chemistry, bacteriology and histology. It is hoped that an additional sum of $100,000 will be collected for an endowment.

THE International Congress of Criminal Anthropology will next meet in 1901, at The Hague, at the invitation of the Dutch government.

THE Scientific Alliance of New York has issued its first bulletin for the year, giving the programs of the different scientific societies included in the Alliance for the month of October. Most of the societies give opportunities for report on work carried out during the summer. Prof. J. A. Allen will report to the Linnæan Society, on October 13th, on a visit to some of the natural history museums of Europe. On October 12th, before the Section of Biology of the New York Academy of Sciences, informal reports will be made by Dr. Bashford Dean and Mr. G. N. Calkins, 'On the Columbia University Zoological Laboratory upon Puget Sound;' by Prof. Henry F. Osborn, 'On the American Museum Expedition to the Puerco and Wasatch Beds;' and by Mr. William J. Hornaday, 'On a Tour of Inspection of Foreign Zoological Gardens.'

THE regular October meeting of the American Mathematical Society will be replaced by a special meeting to be held at Princeton, on Saturday, October 17th, at 3 p. m. Addresses will be made by Professors Felix Klein and J. J. Thomson.

THE following field meetings have been arranged by the Torrey Botanical Club: Oct. 3, Englewood, N. J.; leave foot W. 130th St., 1:15 p. m.; guide, Mr. Fay. Oct. 10, Forbell's L. I.; leave Montauk Ave. Station, King's County Elevated R. R., 1:30 p. m.; guide, Mr. Hulst. Oct. 17, Grant City, Staten Island;

leave foot Whitehall St., 1:30 p. m.; guide, Mrs. Britton. Oct. 24, Richmond Hill, L. I., L. I. R. R.; leave foot East 34th St., 12:50 p. m.; guide, Mr. McCallum. Oct. 31, Pelhamville, N. Y., N. H. and H. R. R., 1:30 p. m.; guide, Mr. Ericson.

THE President and Secretary of the American Physiological Society have sent out an announcement calling attention to the fact that, at the Baltimore meeting of the Society in 1894, it was recommended that 'The Internal Secretion of Glands' be selected as a suitable subject for public discussion by the Society at the next Medical Congress to be held in Washington in the spring of 1897. At the meeting held in Philadelphia in 1895 it was voted that the President of the Physiological Society be empowered to communicate with the Association of American Physicans regarding a joint public session of the two Societies at the Medical Congress of 1897. In accordance with these instructions communication was had with the Association of American Physicians, with the result that the latter body has decided to join with our Society in a public discussion of the above subject at the Medical Congress of 1897. The details of this joint session, so far as the Physiological Society is concerned, are to be arranged by the Council of the Society; but members of the Society are reminded of the importance of carrying out research along the lines covered by the subject chosen for discussion, and it is suggested that the results might be reported on at the December meeting.

A MEETING of the Texas Academy of Sciences was held on October 2d, at which the annual address by the President of the Society, Dr. J. Bruce Halsted, was given, the subject being 'Life and Science in Russia.'

THE American Institute of Electrical Engineers held its first meeting for the season on September 30th. The President, Mr. Lewis Duncan, made an address on 'The Present Status of Power Transmission.'

A COURSE of eight lectures, mainly upon science and travel, has been arranged by the Feld Columbian Museum for Saturday afternoons in October and November. The lectures are as follows: Oct. 3, 'Archæological Explorations in Peru,' Dr. G. A. Dorsey, Assistant Curator of Anthropology, Field Columbian Museum. Oct. 10, 'A Trip to Popocatapetl and Ixtaccihuatl,' Prof. O. C. Farrington, Curator of Geology, Field Columbian Museum. Oct. 17, 'San Domingo,' Mr. G. K. Cherrie, Assistant Curator of Ornithology, Field Columbian Museum. Oct. 24, 'Egypt and What We Know of Her,' Dr. J. H. Breasted, Instructor in Egyptology and Semitics, University of Chicago. Oct. 31, 'The Petroleum Industry,' Dr. D. T. Day, Chief of Division of Mineral Resources, U. S. Geological Survey. Nov. 7, 'Alaska and its Inhabitants,' Prof. George L. Collie, Beloit College, Wis. Nov. 14, 'The Economic Geology of the Sea,' Mr. H. W. Nichols, Curator of Economic Geology, Field Columbian Museum. Nov. 21, 'The Physical Geography of New England,' Dr. H. B. Kümmel, Assistant Professor of Physiography, Lewis Institute.

THE daily papers state that the great engineering work of removing the obstruction in the Danube known as the Iron Gates, between Alt-Orsova, in Hungary, and Gladova, in Servia, has been finally accomplished, and on September 11th the river was opened to navigation with elaborate ceremonies by Emperor Francis Joseph, accompanied by the Kings of Rumania and Servia. The program included a procession of steamers through the Iron Gate.

THE Report of the Tenth Annual Meeting of the American Association for the Advancement of Physical Education contains a number of papers on anthropometry. The Association, through its Committee on Anthropometry and Statistics, is doing a good work in systematizing and improving the anthropometric methods applied in gymnasia. The following are the titles of anthropometrical papers in the present volume: 'Anthropometry Individualized,' by David P. Lincoln, a plea for investigating the laws of growth by studying the growth of individuals, rather than by the generalizing method. 'The Growth of Boys,' by Schuyler P. Moon, a discussion of the proportions of the body during the period of growth. Bowditch's 'Law of Growth and What it Teaches,' by E. M. Hartwell, in which attention is drawn to the correla-

tion between mortality and freeness from certain disorders and the rates of growth. 'Proposed Standard Chart of Proportions of American Females,' by Anna Richards and Bessie Belle Little. 'What Nervous Tests shall we use to Complete the Picture of the Individual?' by G. W. Fitz. 'The Use of Anthropometrical Measurements in Schools,' by Wm. T. Porter.

THE first number of the *Journal of Physical Chemistry* has now been published by the editors, Professors Wilder, D. Bancroft and Joseph E. Treevor. It contains articles by Mr. A. E. Taylor and Prof. Bancroft in continuation of work on Irreversible Cells and on Ternary Mixtures previously published in *The Physical Review* and on Chemistry and its Laws by Dr. F. Wald, starting from Prof. Wolcott Gibbs' propositions concerning the equilibrium of missible substances. 18 pages are devoted to reviews written by a special board consisting of Messrs. W. Lash Miller, E. H. Loomis, C. L. Speyers and R. B. Warder, in addition to the editors. The *Journal* will be issued monthly with the exception of July, August and September, and will contain from 48 to 64 pages.

AT the recent meeting of the British Association Prof. Ramsay read a paper on helium, in the course of which he gave an account of his experiments undertaken with a view to determining the character of helium by comparison with hydrogen, oxygen, argon, acetylene and other gases. He has obtained the remarkable result that different samples of helium have different densities, which indicate that helium may be a mixture of two gases.

Appletons' Popular Science Monthly for October opens with an article by President Mendenhall, in which he reviews seriatim the letters by Mr. Herbert Spencer first printed anonymously in the London *Times* and subsequently, under Mr. Spencer's signature, in the *Monthly*. President Mendenhall finds no difficulty in answering the rather weak arguments of Mr. Spencer, which, indeed, have under his hands the appearance of men of straw set up on purpose to be knocked down.

Nature states that letters have been received from Prof. Sollas, by the Chairman and Secretary of the Coral Reef Boring Committee of the Royal Society, which show that, so far as the main object of the expedition is concerned, the effort has been an almost complete failure. When the party had landed on Funafuti from the 'Penguin,' they selected the most promising site, as it appeared, for a bore-hole. The apparatus was landed and set up, and a bore-hole carried down to a depth of about 65 feet, when further progress became impossible, for material like a quicksand was struck, which choked the bore-hole. Very little solid coral rock was pierced. To pass over the steps then taken, it may be enough at present to say that another attempt was ultimately made nearer to the edge of the island, where there appeared some hope of finding more solid coral rock. This boring was carried down to 72 feet, and then similar difficulties prevented further progress. The material struck was a kind of quicksand containing 'boulders' of coral. As fast as the sand was got out, fresh material poured in, and the water pumped down the tube, with a view of cleaning it, actually flowed out into the surrounding bed, while the coral boulders made it impossible to drive the tubes through the quicksand. So far as the reef was pierced it appeared to be not solid coral, but more like a 'vast coarse sponge of coral with wide interstices, either empty or sand-filled.' Although the expedition has failed in its main object, it has met with great success in all the others. Large collections have been made. Messrs. Gardiner and Hedley have thoroughly investigated the fauna and flora, both land and marine, of the atoll. Dr. Collingwood has obtained information of ethical interest, and Captain Field a series of soundings, both within and without the atoll, which Prof. Sollas states are more complete than have yet been obtained, and must greatly modify our views as to the nature of coral reefs. Of all these matters it would be premature to speak, till Prof. Sollas has returned and been able to give fuller particulars, and Captain Field has reported to the Admiralty.

THE *British Medical Journal* states that a new and unexpected agency is having a most beneficial effect in contributing to the abatement of the smoke nuisance in London. The relative clearness of the London atmosphere within the

last twelve months has been plainly apparent, and the smoke cloud which obscures the London atmosphere appears to be progressively lightening. Mr. Ernest Hart, Chairman of the Smoke Abatement Exhibition in London, frequently pointed out that the greatest contributors to the smoke cloud of London were the small grates of the enormous number of houses of the poor, and a great deal of ingenuity had been exhausted with relatively little success in endeavoring to abate this nuisance. The use of gas fires was urgently recommended, but had hitherto been difficult, owing to its cost and the want of suitable apparatus. The rapid and very extensive growth of the use of gas for cooking as well as lighting purposes by the working classes, due to the introduction of the 'penny in the slot' system, is working a great revolution in the London atmosphere. During the last four years the South London Gas Company alone has fixed 50,000 slot meters and nearly 38,000 small gas cooking stoves in the houses of the workingman.

UNIVERSITY AND EDUCATIONAL NEWS.

THE faculty of Cornell University has resolved that, in place of the degree of Master of Arts, Master of Philosophy, Master of Letters and Doctor of Sciences, the one degree of Master of Arts be conferred; and that in place of the degree of Doctor of Philosophy and Doctor of Sciences, the one degree of Doctor of Philosophy be conferred.

PROF. COLLIER COBB contributes to *Appletons' Popular Science Monthly* for October an interesting article in which he calls attention to the modern plan of instruction in the sciences offered by the University of North Carolina more than one hundred years ago. The course planned in 1792 gave great prominence to scientific studies, especially those which could be applied to the arts. The report of the committee recommended the purchase of apparatus for experimental philosophy and astronomy, in which must be included a set of globes, barometer, thermometer, miscroscope, telescope, quadrant, prismatic glass, electrical machine and an air-pump. The ancient classics were made elective, the degree of B. of A. being obtainable without the study of either Latin or Greek.

DR. D. K. PEARSONS, who had promised $10,000 to the trustees of the Mount Holyoke Association, has agreed to give them $40,000 for the building fund.

Garden and Forest states that the name of the donor of the new range of greenhouses recently completed for the department of botany of Smith College has up to the present not been announced. Last week, however, a bronze tablet placed at the entrance of the Palmhouse bears this inscription: 'The Lyman Plant House. A Memorial Tribute to Anne Jean Lyman, by her Son, Edward Hutchinson Robbins Lyman.'

IT is proposed to create a chair of biology in the University of Christiania, to be filled by Mr. Nansen.

A NUMBER of promotions and new appointments have been made at the Massachusetts Institute of Technology. Four associate professors have been advanced to full professorships. Dwight Porter, in Hydraulic Engineering; Alfred E. Burton, in Topographical Engineering; C. F. Allen, in Railroad Engineering, and Peter Schwamb, in Mechanism. Linus Faunce has been appointed Associate Professor of Drawing. Four new assistant professors have been appointed: George H. Barton, in Geology; William H. Lawrence, in Architecture; George G. Robbins, in Civil Engineering, and Joseph J. Skinner, in Mathematics. Seven assistants have been raised to the rank of instructors. They are William J. Drisko, in Physics; George B. Haven, in Mechanical Engineering; Frank P. McKibben, in Civil Engineering; Alexander W. Moseley, in Mechanical Engineering; James F. Norris, in Organic Chemistry; Joseph W. Phelan, in General Chemistry, and Samuel C. Prescott, in Biology, and in addition A. W. Weysse has been made Instructor in Biology. Fourteen new assistants have been appointed, as follows: In Civil Engineering, Reuben E. Bakenhus, Minor S. Jameson, Charles M. Spofford and Harold C. Stevens; in Geology, Amadeus W. Grabau; in Industrial Chemistry, Leonard W. Goodhue and Harrison W. Hayward; in Mechanical Drawing, Albert J. Wells; in Mechanical Engineering, Edward M. Bragg and Frank B. Masters; in Oil and Gas Analysis,

William L. Root; and in Physics, George K. Burgess, William D. Coolidge and Ralph R. Lawrence.

DR. E. LESSER has been appointed associate professor of dermatology at Berlin and Dr. Chermak to the chair of comparative anatomy and embryology at Dorpat. Dr. Winkler, professor of chemistry, has been appointed director of the School of Mines at Freiberg i. S., and Dr. Godschmidt has been promoted to an assistant professorship of chemistry in the University of Heidelberg.

DISCUSSION AND CORRESPONDENCE.

THE STRAIGHT LINE AS A MINIMUM LENGTH.

TO THE EDITOR OF SCIENCE: In looking over the beautiful new text-book of geometry by Profs. Phillips and Fisher one meets with the following proposition of spherical geometry:

The shortest line that can be drawn on the surface of a sphere between two points is the arc of a great circle, not greater than a semi-circumference, joining these points.

The demonstration given is one which has been given before. It appears, for example, in the treatise of Chauvenet (1869) and also in that of George Bruce Halsted (1885). In connection with this demonstration, the reader can hardly escape noticing that every step of it applies equally well to plane geometry. In fact, it is perfectly easy for any student of Euclid's Elements to construct, step by step, a precisely similar proof of the corresponding proposition of plane geometry:

The shortest line that can be drawn between any two points is the straight line which joins them.

The definition of a straight line given by Profs. Phillips and Fisher, therefore, embodies a statement capable of deduction from the geometrical axioms by a chain of logical reasoning, and as a definition, is on strictly scientific grounds, quite indefensible.

Upon examining Prof. Halsted's book, the definitions of which more closely conform to the Euclidean models, one naturally wonders why this demonstration, even more simple in plane than in spherical geometry, has been introduced only in connection with spherical geometry; and one is led to inquire at how early a point the proposition of plane geometry could properly be introduced.

In attempting to establish between any two lines a relation of equality or inequality, we find ourselves compelled to start from the following principles: *The whole is greater than any of its parts; The whole is equal to the sum of all its its parts; Lines which may be placed so as to coincide are equal.* Using these principles alone, it is evident that we cannot compare every two arbitrary lines in magnitude. In any such comparison we must be able to place one of the lines, or portions of it, in complete or partial coincidence with the other. No direct comparison can be instituted, for example, between a straight line and a line no part of which is straight. For the purposes of the proposition in question, therefore, it is necessary to make the distinct assumption, that *the magnitude of every line is comparable with the magnitude of every other line, and between these magnitudes there exists a relation either of equality or of inequality;* or else, what is better, to await the method of limits and the development, by means of it, of metrical ideas, not only for straight lines, but also for curves. Prof. Halsted, accordingly, in spite of his apparent lateness in introducing the proposition, is guilty of an error in theory. He has attempted to give a complete discussion of a proposition, and appears to believe that he has done so, when in reality assumptions additional to those previously made must be introduced before such a discussion can be undertaken.

It seems worth while to make these criticisms, because the two books above referred to are at other points remarkable for their scientific accuracy, and are of so high an order of excellence generally that the student may not readily appreciate the existence of such errors as occur.

THOMAS S. FISKE.

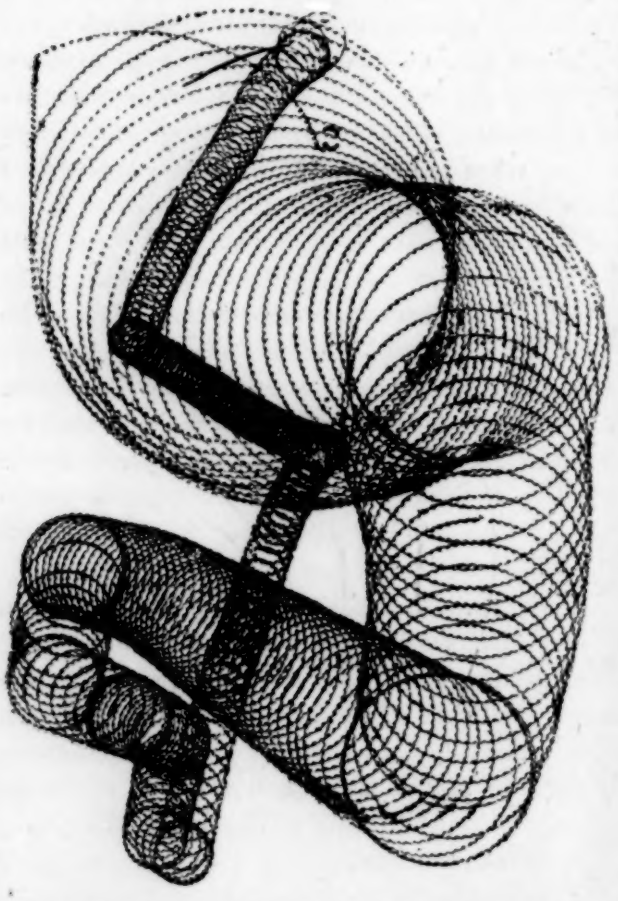
SEPTEMBER 30, 1896.

'A CURVE-TRACING TOP,' AND A CURIOUS OPTICAL ILLUSION.

EDITOR OF SCIENCE: If Prof. Barus will use a smoked glass for his curve-tracing top to spin on, he will get more beautiful tracings than with any lead pencil arrangement. Then let him flow it over with *thin* demar varnish, and

dry; the tracings will be permanent and can be photographed or printed directly by transmitted light. Some ten years ago I had a top made from an excellent gyroscope by removing the supporting ring and fitting a socket on one arm of the axle, in one end of which(the socket) was a female screw. I also had several 'points' made of hardened polished steel, one ending in a very fine point, one in a truncated cone $\frac{1}{10}$ of an inch across the smaller base, others smaller and one in a hemisphere say $\frac{1}{4}$ of an inch in diameter.

These were made to screw into the socket, and the whole most carefully centered by the very best mechanical skill to be had. It was set in motion as humming tops usually are, with a string and wooden handle.



I send you a few of my tracings, with the sharp point.* The abrupt changes in direction are due to my tilting the glass, and are always approximately perpendicular to the inclination, but never exactly so. In the tracings which I send you they begin at the larger curve and grow smaller as they progress. In a few cases, very few out of hundreds, this is reversed. The very small undulations, which are so marked a feature in most of the spirals, are due to minute nutation and precession resulting in the larger effects, as the minute movements of the earth result in the grand precession of the equinoxes.

Sometimes the smaller movements are so very small that they leave no visible traces. All that is seen is what I may call the secondary curve. Sometimes even that so nearly disappears that the path becomes to the eye a straight line.

If the glass plate is 'level,' *i. e.*, approximately so, interesting figures are traced, oblique spirals I may call them, *i. e.*, spirals traced about a point which is not quite stationary.

At first glance they appear merely like flat spirals out of center. Looking at one of them steadily, with one eye or both, you look into a deep basket resting on its smaller end. Look a little longer, and without knowing how it happens, the basket is reversed, it rests on the larger end, and you see only the small bottom and the outside.

Look longer, and without seeing any change you are looking again into the basket.

Now look at the figure with both eyes, but as if focussed for a distant object. You will see two baskets, and probably both in the same position, *i. e.*, both with the small end, or both with the large end, toward you. Keep looking; move the paper quickly a little in any direction, both will reverse; if you have good luck, with a little practice, you will soon get it. Look a little longer. One basket will stand on the small end, and the other on the large one. Focus the eyes on them or near by, and there will be only one basket. This is all well shown in the short spiral I send you.

Double images are common enough, but the new and singular thing is that they appear to each eye so different, and that all these changes take place without effort. You do not see them change, but only that they are changed.

C. B. Warring.

September 26, 1896.

*These were made so long ago that I cannot be certain whether the sharpest point was used, or one that measured $\frac{1}{50}$ of an inch across its face.

EMBRYOS OF THE SMOOTH DOGFISH (GALEUS CANIS).

DURING the early part of September, while working on some integumentary structures of the selachians at the Marine Biological Laboratories, Woods Holl, Mass., I was fortunate enough to secure two female dogfish which had been kept during the summer in the U. S. Fish Commission aquaria. Each fish measured 1.07 m. from the end of the snout to tip of tail. On opening their body cavities I secured three embryos from one and four from the other, the smallest measuring 84 mm., the largest 89 mm. The specimens had well-developed external gills, and were attached by long spirally twisted umbilical cords to the yolk sac, which was still filled with abundant yolk material. One of the embryos has been drawn by Mr. Hayashi, the laboratory artist, and serial sections have been made of another. Fuller description and figures will be given in my paper on the Ampullæ of Lorenzini of the Selachian Fishes.

The condition of the genital organs of the females was interesting. In the first specimen the three embryos were all contained in the right uterus, the left being empty, although the walls of the latter were thickened and highly vascular. At the anterior end of the body cavity the dorsal region of the right ovary was distended with immature eggs. Five of the eggs, varying in diameter from 8 mm. to 15 mm., were supplied with yellow yolk, and were doubtless to be the eggs for next year's young. Other white spherical bodies, presumably very immature eggs, in size from ¼ mm. to 5 mm., were thickly imbedded in the stroma of the ovary. Both uteri were developed equally in the second specimen, each carrying two embryos.

These facts seem to throw some light on the breeding habits of this fish and suggest a means of securing the stages now much needed in the study of the development of the nervous system.

The smooth dogfish is very abundant at Woods Holl throughout the spring and is supplied to the laboratory in great quantities from the fishtraps. This species is viviparous, and if the adult females are dissected in May or early June they are found to carry eggs in the earlier embryonic stages. During July the dogfish begins to leave these shores, and in August it is impossible to get any material. Where the fish spends the winter is not known. The embryos secured during the latter part of July average 10–20 mm., or at most 40 mm. in length. So far as I know, sizes larger than this have not been taken before along the south shore of Massachusetts. When the fish reappear in the early spring the embryos have reached the 'pup' stage, 15–20 cm. in length, and are often born while the fish are in the traps. I have never seen the 'pups' in the uterus of the female later than May.

Hence it seems certain that the breeding habits of *Galeus* are as follows: Eggs which have received their yolk in the ovary during the previous year begin their development in the uterus in late spring. The embryos are carried in the body of the mother until the next April or May, when the young 'pups' are extruded.

It is probable, therefore, that embryos of any required length may be obtained if the large females are secured in April or May, confined in as natural surroundings as possible, and killed when the young have reached the stage of development desired.

JAMES E. PEABODY.

WOODS HOLL, September 10, 1896.

THE LAW OF RHYTHMIC MOVEMENT.

IT has long been known that in such rhythmic movements as walking, running, etc., a certain frequency in the repetition of the movement is most favorable to the accomplishment of the most work. Thus, to go the greatest distance in steady traveling day by day the horse or the bicyclist must move his limbs with a certain frequency; not too fast, otherwise fatigue cuts short the journey, and not too slow, otherwise the journey is made unnecessarily short. This frequency is a particular one for each individual and for each condition in which he is found. Any deviation from this particular frequency diminishes the final result.

Some measurements that I have already made on natural and unnatural rhythms have suggested a law governing the amount of deviation from the natural rhythm and the resulting loss.

The rhythm used is that of a movement of the forearm. A series of movements is made in a natural rhythm, then other series in unnatural rhythms. The average and the mean variation (mean error) are computed for each series. The psychological mean variation (all apparatus errors being rendered negligible) is a good measure of the subject's irregularity or of the difficulty of his mental processes. Using the mean variation thus as a measure of the disadvantage of a rhythm, we can express the relation of disadvantage to length as $m = f(r)$ where m is the mean variation and r the length of the rhythm. Now, the law that I believe myself able to assert is

$$\frac{m}{\text{abs}\ (r-R)} = \text{const.}$$

where m and r have the same meanings as before, R is the length of the natural rhythm and abs indicates that the sign of the quantity is disregarded. In other words, the amount of irregularity is proportional to the amount of deviation from the natural rhythm.

The full proof of the law with a determination of the constants I hope to furnish during the coming year.

E. W. Scripture.

Yale University, September 20, 1896.

SCIENTIFIC LITERATURE.

The American Lobster: A Study of Its Habits and Development. By Francis Hobart Herrick.

This monograph, issued as a portion of the Bulletin of the U. S. Fish Commission for 1895, has over 250 pages of text and 64 plates, and represents the work of the author as an investigator of the U. S. Fish Commission from 1890 to 1895. Its general appearance is quite up to the improved standard of the more recent government publications. The typography is good and many of the plates are really excellent.

It is presumed that the publications of the Fish Commission will have some practical bearing upon the innumerable problems of fish-culture, and Dr. Herrick has not confined himself to mere questions of morphology and embryology, but, following the suggestion of Prof. Rathbun, has endeavored to determine the *natural history* of this most important and strangely persecuted invertebrate; and it is to be hoped that with these natural data at hand the government will adopt some rational method of experimentation which shall finally lead to successful lobster culture.

In the Introduction the author considers the immediate questions of nomenclature, the methods of lobster capture, and the rise and inexcusable decline of the lobster fishery in America.

Chapter II. deals at considerable length with the general subject of reproduction. The essential and secondary organs are described, the peculiar pairing habits of certain Crustacea are mentioned, and the methods of oviposition are discussed. In describing the spermatozoa the author writes: "The sperm cells have a characteristic shape and are absolutely immobile in the conditions under which they are ordinarily observed, but it is impossible to suppose that this is always the case." The reviewer has seen the spermatozoa in active movement, swimming across the field of the microscope with the same nervous contractions that are characteristic of the Hydromedusæ.

The facts collected in reference to the time of egg-laying and period of incubation are very complete, and indicate the time when artificial hatching should commence. We cannot, however, agree with the author that there are at present adequate data for the assumption that eggs are frequently deposited during the fall and winter. When the temperature of the water is known to be so important a factor in the rate of development, and when the range of temperature variation is from 35.5° F. in February to 71.4° F. in August, it is extremely hazardous to estimate the actual age of 'winter' embryos from the known age of those whose growth has been accelerated by the warmer water of midsummer.

The data illustrating the law of production, arranged in Table XV., have been gathered from an examination of 4,000 adult lobsters, and represent a vast amount of work. The rearrangement of this material in other tables, and the author's conclusions regarding the period of greatest fertility, are especially instructive.

In dealing with the destruction of the egg-lobster and its spawn, it is to be regretted that

Dr. Herrick has not expressed disapproval of the destructive methods of 'lobster-hatching' that have been practiced in certain hatcheries for several seasons past.

The subject of molting and the function of the gastroliths are exhaustively treated, the literature reviewed, erroneous ideas corrected, and many interesting observations recorded.

In Chapter IV., on the Regeneration of Lost Parts, we read, "the new limb appears to arise mainly by growth of the connective-tissue cells already present in the stump;" and, further on, "the fibrous tissue becomes gradually differentiated into the muscles, blood-vessels and nerves, as in an embryo." It is unfortunate that figures are not given illustrating this method of regeneration. The sections on Variation will supply valuable material for one interested in the lines of investigation outlined by Bateson.

Chapters XI.–XIII. deal with general questions of crustacean development and larval life, and are excellently illustrated by prints and colored plates.

We may add in conclusion that, from the breadth of the field covered, Dr. Herrick's paper will be frequently consulted, not only by those devoted to artificial fish-culture, but by working naturalists, whether embryologists, physiologists or students of variation.

H. C. BUMPUS.

BROWN UNIVERSITY.

ISOPENTANE AND HEXANE.

The Thermal Properties of Isopentane. By SYDNEY YOUNG, D. Sc., F. R. S., University College, Bristol. (Communicated to the Physical Society of London.)

The isopentane employed in this research was procured from Kahlbaum, of Berlin; the substance is obtained as a bye-product in the manufacture of amylene from amyl alcohol by the action of zinc chloride. The isopentane was purified by repeated agitation with concentrated sulphuric acid and with a mixture of sulphuric and nitric acids and by subsequent fractional distillation.

The vapor pressures were determined at temperatures from —30° to the critical point, 187.8°; the orthobaric volumes of a gram of liquid from 0° and of saturated vapor from 10° to the critical point; and the volumes of liquid and of unsaturated vapor between wide limits of temperature and pressure.

The experimental methods employed are described in the original paper and, in regard to pressure, the error due to the vapor pressure of mercury is fully discussed. The volumes of a gram of liquid and vapor were plotted against the pressure and from the isothermals isochors were constructed; it was found that at large volumes and just about the critical volume the isochors were straight, at any rate within the limits of experimental error, but that at volumes smaller than the critical volume the values of $\frac{dp}{dt}$ increased slightly with rise of temperature, whilst at volumes greater than the critical volume they diminished slightly with rise of temperature.

The formula $p=bT-a$ at constant volume (Ramsay & Young, Phil. Mag., 1887, 435, *cf.* Amagat, Compt. Rend., 94, 847), is therefore not quite, though very nearly, true for isopentane, and the results seem to confirm the conclusion arrived at by Amagat in the case of the substances examined by him that the values of b are not absolutely constant.

Values of b and $\frac{10{,}000}{bv}$ and of a and $\frac{10^{10}}{av^2}$ for volumes of a gram from 1.58 to 4000 cub. cms. are given in the original paper.

The absolute temperatures (boiling points) and molecular volumes of liquid and saturated vapor were read from the curves at pressures 'corresponding' to those adopted in previous papers on the 'Generalizations of Van der Waals regarding Corresponding Temperatures, Pressures and Volumes,' (Phil. Mag., Feb., 1892, 153; Jan., 1894, 1; Trans. Chem. Soc., 63, 1191) and the ratios of the temperatures and volumes to the critical constants were calculated. The ratios prove that isopentane belongs to Group I in the classification of substances previously adopted (Phil. Mag., Jan., 1894, 1).

The ratio of the actual to the theoretical density at the critical point, 3.73, agrees well with the ratios for the other members of Group I (3.65 to 3.83), and with that for carbon dioxide (3.62) deduced from Amagat's observations.

From these results it may be concluded that the molecules of liquid isopentane are simple, like those of the gas.

Specific Volumes of Isopentane Vapor at low Pressures. By Sydney Young, D. Sc., F. R. S., and G. L. Thomas, B. Sc., University College, Bristol. (Physical Society of London.)

The specific volumes at low pressures were determined in a Hofmann's apparatus, modified in such a manner that the volume as well as the temperature could be altered at will. This apparatus was first employed by Ramsay and Young (Phil. Trans. 1887 A. 58), but various improvements have been introduced, and are fully described in this paper.

Isopentane from Amyl Iodide. By the same authors. (Physical Society of London.)

A specimen of isopentane was prepared by the action of very concentrated hydrochloric acid (added drop by drop very slowly) and zinc slightly coated with copper on an ice-cold alcoholic solution of amyl iodide. The isopentane was purified by treatment with bromine and subsequent fractional distillation.

Determinations were made of the boiling point, specific gravity at 0°, the critical temperature and pressure and of the vapor pressures and specific volumes of liquid and saturated vapor at a few temperatures.

The boiling points, specific gravities and critical constants of both specimens of isopentane are given below:

	Isopentane from Amylene.	Isopentane from Amyl Iodide.
Boiling point (mean).....	27.95°	27.95°
Specific gravity at 0°.....	0.63924	0.63935
Critical temperature.....	187.8°	187.8°
Critical pressure.....	25010 mm.	25030 mm.
Critical volume of a gram..	4.266 cb. cms.	——

The Vapour Pressures, Specific Volumes and Critical Constants of Normal Hexane. By the same authors. (Communicated to the Chemical Society of London.)

The normal hexane employed in this investigation was obtained from Kahlbaumit; it had been prepared by the action of sodium on propyl iodide. It was purified by treatment with mixed sulphuric and nitric acids and by subsequent fractional distillation.

The vapor pressures and the volumes of a gram of liquid and saturated vapor were determined at a series of temperatures, and the ratio of the absolute temperatures (boiling points) and the volumes to the critical constants were calculated at a series of pressures 'corresponding' to those previously adopted.

Like isopentane, normal hexane was found to belong to group I, and the molecules of liquid in this case also are probably simple like those of the gas. The ratio of the actual to the theoretical density at the critical point is 3.83.

As regards the comparison with isopentane, it is noticed that the absolute temperature ratios at 'corresponding' pressures are higher for the paraffin of higher molecular weight, and in this respect the paraffins seem to resemble the esters (Trans. Chem. Soc. 63, 1252), for which the ratios increase without exception with rise of molecular weight.

In the case of the esters the volume ratios appear to be independent of molecular weight, but, for isomeric compounds, to depend to some extent on the constitution. It seems probable that this may also be the case for the two paraffins studied, but an investigation of other paraffins will be necessary before these points can be decided.

The relations of pressure to temperature at constant volume were investigated through a small range of volume (from 9 to 33 cub. cms. per gram; critical volume = 4.268 cub. cms.), and it was found that with hexane as with isopentane the values of $\frac{dp}{dt}$ at these volumes diminish slightly on rise of temperature.

Normal Hexane from Petroleum Ether. By the same authors. (Chemical Society of London.)

An attempt was made to obtain a pure hexane from 'petroleum ether' by fractional distillation by the method employed by the authors in the separation of ethyl acetate from a mixture of methyl, ethyl and propyl acetates (Phil. Mag. Jan. 7, 1894, 8). A dephlegmator 125 cms. in length, with twelve constrictions (Chem. News, 77, 177) was employed.

Each fraction was weighed and its temperature range noted and corrected for the thermometric error and for the difference between the barometric reading and 760 millims. The ratio of the weight of any fraction ($\triangle w$) to its

temperature range ($\triangle t$) gives, as a rule, a measure of the purity of the liquid, though in the early fractionations of a complex mixture this cannot always be relied on. Thus, in the 4th fractionation, the fraction coming over between 65° and 66° had the highest value of $\frac{\triangle w}{\triangle t}$, whereas in the 16th fractionation the corresponding fraction (65° to 66.85°) had the lowest value. In the first case a mixture of normal and iso-hexane was separating rapidly from the pentanes and heptanes in the petroleum ether; in the second considerable progress had been made in the separation of normal from iso hexane (B. P^s 69°0 and about 61° respectively).

After the 16th fractionation it was decided to proceed at first with the separation of normal hexane only, and after the 31st preliminary fractionation it was considered that the separation had proceeded far enough for the final series of fractionations to be undertaken (*loc. cit.*).

The normal hexane obtained by the final fractionation of the fractions boiling at and above 69.1°, when distilled from phosphorus pentoxide, boiled at 69.1° or 0.1° higher than the hexane from propyliodide; its specific gravity at 0° was 0.68478 or 1.15 per cent. higher.

The hexane was, therefore, shaken repeatedly with a mixture of concentrated nitric and sulphuric acid, when considerable heat was evolved and some m-dinitrobenzene was formed. The impurity, which could not be separated by fractional distillation, was, therefore, benzene with, possibly, some hexanaphthene.

The other fractions were separately treated with the mixed acids and after further fractionation a product was obtained boiling at 69.05° and with the specific gravity 0.67813 at 0° or only 0.17 per cent. higher than that of pure hexane.

The boiling points, specific gravities and critical constants of the two specimens of normal hexane are given below:

	Normal Hexane from Propyl Iodide.	Normal Hexane from Petroleum Ether.
Boiling point.....	69.0°	69.05°
Specific gravity at 0°.....	0.67696	0.67813
Critical temperature.....	234.8°	235.15°
Critical pressure.....	22510 mm.	22560 mm.
Critical volume of a gram...	4.268 cb. cms.	

SOME RECENT MEXICAN PUBLICATIONS.

MEXICAN men of science are doing much active scientific work, as is shown by the extent and value of the following publications:

1. *Biblioteca Botánico-Mexicana. Catalogo Bibliografico, Biografico y Critico de Autores y Escritos Referentes a Vegetales de Mexico y sus Aplicaciones, desde la Conquesta Hasta el Presente. Escrito por el* DR. NICOLAS LEÓN, Mexico, 1895.

This work of 375 pages is comparable to Sereno Watson's Bibliography of American Botany, issued a number of years since. The number of separate entries in the main alphabetically arranged list is 805, making, with those of the appendix (82), a total number of titles quoted of 887. The work aims at being a complete list of the floras and books, as well as papers and separates, dealing with the plants of Mexico published since the Conquest. A fair number of American authors are cited, and their botanical work reviewed briefly or at some length; among such may be mentioned Audubon, Bailey, Chapman, Eaton, Eggers, Engelmann, Gray, Parry, Pursh, Riley, Rose, Rothrock, Torrey and Trelease. Short biographical sketches of the botanists who explored Mexico, as far as known, are added, as also an account of their work while in the field and the extent and importance of their collections. Botanists of the United States, Canada and Europe not familiar with this comprehensive work would do well to procure a copy from the author or from the printer in the city of Mexico; Oficina Tip. de la Secretaria de Fomento.

2. *Informe que rinde á la Secretaria de Fomento. El Director del Instituto Médico Nacional* DR. FERNANDO ALTAMIRANO. *Sobre algunas excursiones á las Montañas del Ajusco y Serranía de las Cruces.* Mexico, 1895.

This pamphlet of some 64 pages gives an account of a new amphibian *Amblystoma Altamirani*, A. Dugés, with a colored lithographic plate of the same, as well as an account of an

insect *Lachnus Strobus*, Fitch. The botanical portion deals with a description of the region of Ajusco and of Las Cruces explored, with an enumeration of the plants collected, as also meteorological tables showing the climate of Guadalupe, Ajusco, City of Mexico, and Hacienda de Eslava for July, 1895. A description of the plants new to the valley of Mexico forms a portion of the pamphlet, the following plants being noted, *Halenia candida* Ramirez and *Passiflora eslavensis* Ramirez. The pamphlet closes with a discussion of hydrology of the region, in which chemical analyses are shown of the potable waters, which might be introduced into use.

3. One of the most interesting publications recently issued by the National Medical Institute, under the auspices of the Secretary of Agriculture and the direction of Fernando Altamirano, is one dealing with the gradual disappearance of Lake Texcoco, which is being hastened by the drainage operations now being carried forward to completion. The publication entitled *Estudios referentes a la Desecación del Lago de Texcoco Año de 1895, Primera Parte*, is one of 126 pages, dealing first with the meteorology of the region and the rate of evaporation from the lake. The second portion deals with the fauna of Lake Texcoco, by Prof. Herrera, a most interesting study to the biologist; a discussion of the influence of malaria on the hygiene of the capital follows, with a description of the geography and climatology of the lake, presented by Dr. Domingo Orvañanos. Accompanying the report are a series of graphic tables illustrative of the evaporation and meteorology of the lake.

4. *Anales del Instituto Medico Nacional. Tomo I. Num. 8*, Mexico, 1896.

This number is devoted to Materia Medica, or a pharmaceutical description of certain Mexican plants, such as: *Aristolochia fragrantissima*, Ruiz., *A. fœtida*, H. B. K., *A. odoratissima*, L., *A. anquicida*, L., *Mikania Houstonis*, Wild., *M. scandens*, Wild., *Dorstenia contrayerba*, L., *Pluchea, odorata*, Cav., *Erynguim aquaticum*, L., *Poinsettia pulcherrima*, Graham, and a chemical study of *Jatropha spatulata*.

John W. Harshberger.
University of Pennsylvania.

NEW BOOKS.

Life Histories of North American Birds. Charles Bendire. Washington, Government Printing Office. 1895. Pp. ix + 518.

A History of Elementary Mathematics. Florian Cajori. New York and London, The Macmillan Company. 1896. Pp. viii + 304. $1.50.

An Outline of Psychology. Edward Bradford Titchener. London and New York, The Macmillan Company. 1896. Pp. xiv + 352. $1.50.

The Crowd, A Study of the Popular Mind. Gustave le Bon. New York, The Macmillan Company. 1896. Pp. xxiv + 230. $1.50.

Education of the Central Nervous System. Reuben Post Halleck. New York and London, The Macmillan Company. Pp. ix + 258. $1.00.

Elements of Solid Geometry and Mensuration. Henry Dallas Thompson. New York and London, The Macmillan Company. 1896. Pp. vii + 199. $1.25.

Röntgen Rays and Phenomenon of the Anode and Cathode. Edward P. Thompson and William A. Anthony. New York, D. Van Nostrand Company. 1896. Pp. xix + 190.

Report of the Sixth Meeting of the Australasian Association for the Advancement of Science, held at Brisbane, January, 1895. Edited by John Shirley. Published by the Association, Sydney, N. S. W. Pp. xxxiv+875.

Peru: Beobachtungen und Studien über das Land und seine Bewohner. E. W. Middendorf. Berlin, Robert Oppenheim. 1893, 1894, 1895. Vol. I., xxvii+638; Vol. II., xii+424; Vol. III., xv+603. M. 48.

Handbuch der Praktischen Gewerbehygiene mit besonderer Berücksichtigung der Unfallverhütung. Herausgegeben von Dr. H. Albrecht. Mit 756 Figuren. Berlin, Robert Oppenheim. 1896. Pp. xi+1053. M. 27.

Bulletin of the U. S. National Museum, No. 47: The Fishes of North and Central America. David Starr Jordan and Barton Warren Evermann. Part I. Washington, Government Printing Office. 1896. Pp. lx+1240.